AMERICAN MUSEUM OF NATURAL HISTORY
Guide Leaflets 24-35
1907-1911

24. Mead, Chas. W.	Peruvian Mummies
25. ...	Pioneers of American Science
26. Hovey, Edmund Otis	The Foyer Collection of Meteorites
27. Dahlgren, B.E.	The Malaria Mosquito
28. Chapman, Frank M.	The Habitat Groups of North American Birds
29. Skinner, Alanson	The Indians of Manhattan Island and Vicinity
30. ...	Stokes Paintings representing Greenland Eskimo
31. ...	A Brief History of Antarctic Exploration
32. Dickerson, Mary C.	Trees and Forestry
33. Winslow, C.-E.A.	Protection of River and Harbor Waters from Municipal Waste
34. Fassett, E.C.B.	Plant Forms in Wax
35. Sherwood, Geo.H.	General Guide to Exhibition Halls...

AMERICAN MUSEUM OF NATURAL HISTORY

Peruvian Mummies

By CHARLES W. MEAD
Department of Ethnology

GUIDE LEAFLET NO. 24

MARCH, 1907

2

CHULPAS, OR BURIAL TOWERS

Sillustani, Peru

Peruvian Mummies

AND WHAT THEY TEACH

A GUIDE TO EXHIBITS IN THE PERUVIAN HALL

By CHARLES W. MEAD

DEPARTMENT OF ETHNOLOGY

NO. 24

OF THE

GUIDE LEAFLET SERIES

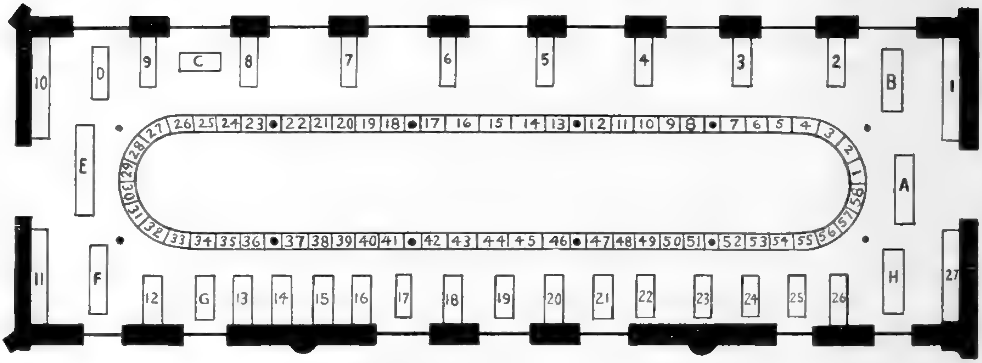
OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. March, 1907

NORTH



PERUVIAN HALL NO. 302.

Gallery Floor, West Wing.

PRESENT LOCATION OF THE OBJECTS DESCRIBED IN THIS LEAFLET.

	CASE
Mummy bundles	U 27
Mummies	U 27
Prayer sticks	R 4–5
Mummified animals	U 27
Trephined skulls	U 26
Skull Collection	U 26
Implements of war and the chase	U 21
Gold and silver objects	A
Baskets, mats and nets	R 17–18
Cloths	U 1
Materials and implements used in weaving	B
Quipus, or Record Fringes	R 1, 2
Coca leaves and outfit for chewing	R 11
Pottery	U 9, 10, 11, 12 and D, E, F
Chicha jars	On top of U 1, 3, 4, 5, 6, 7, 27
Collection from the West Indies	U 2
Musical Instruments	U 25

"U" refers to the upright cases; "R," to the railing cases.

6

PERUVIAN MUMMY BUNDLES AND MUMMY

PERUVIAN MUMMIES AND WHAT THEY TEACH.

By Charles W. Mead,

Department of Ethnology.

ANCIENT Peru, the land of the Incas, comprised not only the region included within the present Republic of Peru, but also the greater part of Ecuador, Bolivia and Chile and was about equal to that portion of the United States lying east of the Rocky Mountains. The Incas proper were a powerful tribe of warlike people inhabiting the great central plateau, from which dominating position they extended their conquest in all directions. They developed a much higher order of civilization than was found in other parts of the continent by the early European explorers, and the empire under their sway included many tribes speaking different dialects.

The history of the Ancient Peruvians must to a large degree be read in their graves, since they left no written records and the Spanish conqueror destroyed many of their cities and suppressed their customs. Like many other peoples the Peruvians bestowed much tender care on their dead, carefully preparing them for burial and placing with them in the ground many objects which were dear to them in life. Methods of burial are so intimately connected with the religious and other customs of a people that in the absence of other sources of information a study of graves or tombs may be expected to lead to important results. Fortunately for the archæologist, climatic conditions in some parts of Peru are such that "burials" have been well preserved. The region west of the Peruvian Cordillera, a narrow strip along the coast, is in the main a desert, the only fertile spots being the narrow valleys of the small rivers flowing down to the Pacific.[1] The tombs and graves are usually found on elevated places outside of the valleys where the extreme dryness of the air combines with the nitrous character of the sand, into which moisture has seldom found its way, to desiccate and preserve the bodies of the dead thus mummifying them naturally. The same factors have

Importance of the Burials

[1] The visitor is referred to the relief map of South America on the left as he enters the hall for a clear exposition of the topographic features of the region.

caused the clothing and objects placed with the dead to be preserved for many centuries.

Preparation for Burial

As a rule the bodies were prepared for burial by placing them in a sitting position with the knees drawn up and the head and hands resting upon them, as is shown in the right-hand figure on page 6. Sometimes, however, as appears from burials in the Chira Valley, in the extreme northwest of Peru, the body was extended at full length. A few of the extended bodies have been found in other parts of the country, and two examples of this form from Surco, Peru, are in the collection. After the body was placed in position, it was enveloped in wrappings of various kinds. Sometimes the body was covered with fine cotton cloth, over which were placed finely woven blankets or ponchos of the wool of the vicuña or the alpaca, with designs in various colors.

Mummy Bundles

The body and its wrappings were bound together by a net-work of stout cord of vegetable fibre; by a piece of strong cloth sewed together in the form of a closed sack, or in some localities by a casing of woven rushes. The "mummy bundle" was surmounted by the so-called "false head," which was sewed to its upper surface. The significance of this practice is unknown. These false heads, many of which are present in the collection, were made of cloth and filled with different vegetable substances. The face was represented in various ways: sometimes by a mask of wood or clay, but often the eyes, nose and mouth were made of wood, shell, gold or silver and fastened directly to the cloth by means of thread. To the outside of the mummy bundle were often attached several of the prayer sticks or sepulchral tablets which are frequently found in considerable numbers in the sand about the grave. These are either in the form of a cross wound with variously colored yarns, or a framework of split reeds, covered with cloth upon which rude designs are painted. Favorite animals were sometimes buried with the dead as is shown by the mummified bodies of a dog and a parrot in the collection.

Huacas

The manner of interment of the mummy bundle and its accompaniments differed in various localities. In the coast region many of the mummies are found in little vaults, or "huacas," of adobes or flat stones roofed with sticks or canes, overlaid with mats or a layer of rushes, which prevented the earth covering from filling the grave. These vaults usually contain from one to four bodies.

NATURALLY MUMMIFIED BODY

Copper Mine at Chuquicamata, Chile

Burials in stone towers or "chulpas" seem to have been confined chiefly to the Aymará Indians of the Callao, the great plateau of the Andes which includes the basin of Lake Titicaca and lies between the two maritime cordilleras and the eastern range, out of which rise the lofty volcanic peaks of Illimani and Sorata. In plan these chulpas are either circular or rectangular and are spoken of as round or square towers. A round burial tower is shown on page 2. Dr. von Tschudi found chulpas in the Department of Junin, which may have been built by Aymará *mitimaes*, or translated colonies. Describing the burial towers near Palca, E. G. Squier says:[1] "Primarily these chulpas consisted of a cist, or excavation, in the ground about four feet deep and three feet in diameter, walled up with rough stones. A rude arch of converging and overlapping stones, filled in or cemented together with clay, was raised over this cist, with an opening barely large enough to admit the body of a man, on a level with the surface of the ground, towards the east. Over this hollow cone was raised a solid mass of clay and stones, which, in the particular chulpa I am now describing as a type of the whole, was 16 feet high, rectangular in plan, 7½ feet face by 6 feet on the sides. The surface had been rough-cast with clay, and over this was a layer of finer and more tenacious clay or stucco, presenting a smooth and even surface."

Chulpas

One of the most remarkable specimens that the Department of Ethnology has acquired is a naturally mummified body which was found in an old copper mine at Chuquicamata, Province of Antofagasta, Chile, and which is illustrated on page 10. The condition of the body shows that the unfortunate miner was caught by a cave-in of the roof and partly crushed. The mummification seems to have been produced in part by the action of copper salts and not to have been altogether a desiccation due to the dryness of the region. The skin has not collapsed on the bones, as in the mummies found usually in the region, but the body and limbs preserve nearly their natural form and proportions, except for the crushing already mentioned. No analysis has yet been made of the tissues, so that it is too early to hazard any supposition as to the chemical changes which they have undergone. Mines in this neighborhood have been worked for an unknown length of time upon a peculiar deposit of atacamite, a

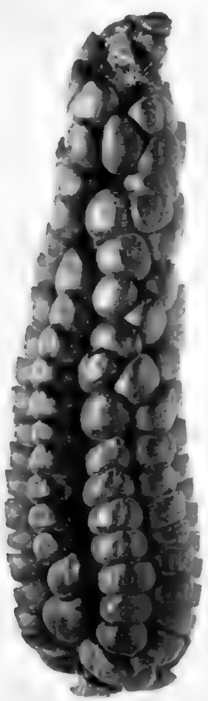
Natural Mummy

[1] Squier's Peru, p. 243.

hydrous chloride of copper, which is much prized on account of its easy reduction. The age of the mummy is unknown, but it is supposed to be pre-Columbian.

Weapons and Implements

The story told by the objects found with the Peruvian dead is in part the story of ancient Peruvian life. The objects in the Peruvian collection in the hall, most of which have come from graves and mummy bundles, have been arranged so as to tell part of this story. For example we find with the bodies of men slings for throwing stones, stone-headed clubs and bolas (rounded stones joined by cords), showing the weapons and implements of war and the chase. With the mummy bundle of the woman have been found work-baskets, filled with threads and yarns of various colors, needles of thorn and copper, the implements used in weaving, such as spindles and shuttles, or the stones used in smoothing and polishing the outside of pottery vessels. Woman's work in ancient Peru is indicated by the presence or absence of objects familiar to us of the present day. Corn, beans and other foods were usually placed beside the body in the grave, together with vessels used in eating and drinking. These objects indicate not alone the belief of the people in a future world and the necessity of sustaining the spirit in its journey thereto, but they also show that the people were well advanced in agriculture, and we are enabled to determine the kinds of plants cultivated and in many cases even the methods by which they were prepared for use.



EAR OF CORN. FOUND WITH A MUMMY

Furthermore the objects found in the graves prove that in the working of copper, silver and gold the ancient Peruvians take high rank, and

CUP OF BEATEN GOLD AND STRING OF GOLD BEADS

show that the people knew how to exploit and treat the ores occurring in their land. Among copper implements there may be seen in the collection a great variety of spear points, club-heads, digging and planting implements, knives and axes. Tweezers are among the most familiar objects from the graves, and are often found suspended from the neck of a mummy by means of a cord.

Use of Copper

Some of the most notable of the gold objects are a cup beaten from a single piece, and ornamented in repoussé-work; human and animal figures, both solid and hollow, and beads and pins. The illustration on page 13 shows the gold cup and a string of large gold beads. In silver there are cups and vessels which, like the gold cup, are beaten from single pieces and are often ornamented with human or animal figures and other designs. Silver tweezers in many fanciful forms, pins and a variety of ornaments have been found in and with the mummy bundles. These objects prove that the makers were familiar with the processes of casting in moulds, beating and soldering. Many of the hollow figurines were made in three or more pieces and the parts soldered together.

Gold and Silver

Another remarkable class of objects is to be found on the right as one enters the hall. Here are many garments and pieces of cloth which were found wrapped around the dead or deposited in the graves. A glance at this part of the collection will show the ancient Peruvians had great skill in the art of weaving. Upon closer examination it will appear that they were familiar with most of the weaves known to modern people, from the finest gobelins to the coarsest cotton cloth. Many of the specimens cannot be excelled at the present time. The looms used were of the simplest description, consisting of two cross-sticks, one at the top, and the other at the bottom. The warp threads were stretched from one to the other, while the woof or filling was passed over and under these by a shuttle. So the weaving of these most perfect fabrics may be said to have been by hand. In this respect they may stand in contrast to the modern machine methods. In addition to the excellence of weave Peruvian cloth is unique in decoration. The designs are woven in and consist of geometric figures and conventionalized representations of men, pumas, jaguars and various kinds of birds and fish. Some of the forms are illustrated on page 16. A part of the decorative effect is due to the regular repetition of the same design in different colors.

Cloth and Weaving

That the Peruvian should also take high rank as a potter will be gathered from even a superficial study of the collection of all forms of pottery at the west end of the hall, since many of the vessels show real beauty of outline and form and excellence in their painted decoration. These qualities seem the more remarkable when we consider that the

PIECES OF CLOTH FOUND WITH MUMMIES

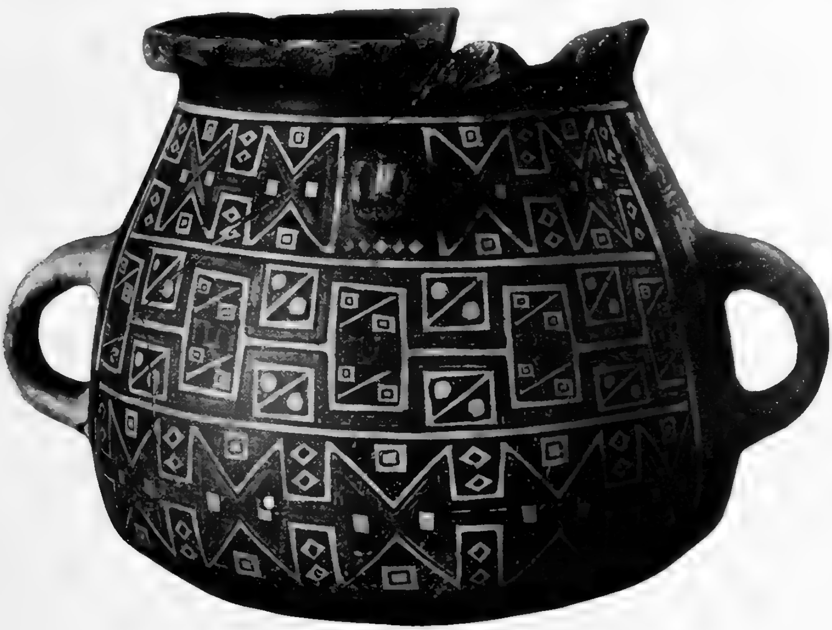
makers had no knowledge of the potter's wheel and were unacquainted with the art of glazing. Some of the vessels were shaped by hand, but others show that they were formed by means of moulds. The body was moulded in two parts which were joined by being pressed together. Spout or handle, if desired, was then attached, and all irregularities in the junctures remedied by scraping and rub-

Pottery

POTTERY WATER-JAR WITH CORN DECORATION

bing. Moulds were often used in making many of the animal heads and human figures that adorn these vessels. The decoration was put on with paint, and, after firing, the vessels were polished by rubbing with a smooth pebble.

In the absence of an aboriginal written language in Peru and on account of the meagreness of the descriptions left by the first Europeans who visited the country, it is fortunate for the student of Peruvian archæology that the potter often represented by the shape of his vessel or in its



POTTERY VESSEL WITH PAINTED DECORATION

decoration forms and customs which were familiar to him in his every-day life.

Human figures

Representations of the human figure are common. Some of these show the manner of wearing the poncho and other articles of clothing. Some have in the lobe of the ear the large cylindrical ear-ornaments which led the Spaniards to nickname these people "Orejones" — big ears. It would be impracticable, however, to mention here more than a few of the subjects depicted. On one vessel a man pursues and kills a deer with a spear; on another a hunter is returning with the body of a deer thrown across his shoul-

ders. Some jars show the manner of catching fish by means of hook and line, while others portray men and women carrying water jars and other burdens by means of a strap passing around the forehead. Here we see a man with his favorite bird, evidently of the parrot family, perched upon his shoulder; there a dance in progress, with several of the figures playing upon musical instruments.

Animal figures

These potters were very fond of moulding their clay into animal forms, and they have left us more or less truthful representations of many of the species familiar to them. Their favorite models appear to have been the puma, jaguar, monkey, llama, Guinea-pig, lizards, birds of the parrot family, the king vulture and a number of shells and vegetable forms. A complete list would include most of the animal and many of the vegetable forms of Peru.

Chicha

Everywhere, except in the most elevated parts of the country, maize was not only the staple food of the people, but also was the source of their favorite intoxicating beverage,— *chicha*; hence it was but natural that they should so often represent the grain on their vessels. This was very simply and perfectly accomplished. A mould was made from an ear of corn and dried in the sun or fired. Into this clay was pressed; which on being removed would be a facsimile of the ear. This was joined to the jar while both were still in a plastic condition, after which the whole was fired and polished. A corn jar is represented in the illustration on page 17.

Trephined skulls

Although this guide relates chiefly to burials, it may not be out of place to call attention to some peculiarities of Peruvian skulls. The skulls of all races are of great scientific value, but those of Peru are of particular interest, because many of them bear the marks of surgical or sacrificial operations. The Museum collection of Peruvian skulls is so extensive that only a representative series is on exhibition. This contains many examples showing trephining, artificial deformation and pathological conditions, together with several normal Peruvian skulls for purposes of comparison.

In Perú, where stones from slings and wooden clubs with heads of stone and copper were the common offensive weapons, complex fractures of the skull with depression of its bony plates must have been common. There seems no reason to doubt that trephining was resorted to as a means of relief in such fractures, and that sometimes cures were effected by this treatment. It is also probable that the operation in many

21 TREPHINED SKULLS FROM ANCIENT PERUVIAN GRAVES

cases was a part of some religious ceremonial, since some of the trephined skulls in the collection show distinct orientation of the wound and present no indication of lesion. Implements of copper and bronze and knives of stone and obsidian must have been employed in the operation, which was performed with skill.

Artificial deformation of the head was extensively practised in ancient Peru and was accomplished by means of ligatures applied in infancy. The form taken by the head was determined by the manner in which these bindings were applied. The pathological skulls show the ravages of disease in the bones of the cranium.

THE QUIPU.

The Quipu is a fringe consisting of a main cord with other cords of various colors hanging from it. In the fringe knots of different kinds were tied. The ancient Peruvians, having no written language, made use of the quipu to keep their accounts and possibly to record historic incidents. By the color of the cord, the kind of knot, the distance of the knots from the main cord and from each other, many facts could be recorded and preserved. The maker of a quipu had a system which was to a great extent arbitrary, and which had to be explained when the quipu was placed in the keeping of another.

COCA CHEWING.

The coca plant (*Erythroxylon coca,* Lam.) grows wild in the mountainous regions of Peru and Bolivia and was cultivated before the Conquest, as it is to-day, in districts from 2,000 to 5,000 feet above the sea. It is valued for its stimulating narcotic properties, and the present Indians will often carry heavy burdens for several days without food, if furnished with a plentiful supply of coca. The leaves are gathered and dried in the sun and then chewed mixed with unslacked lime in the same way the betel is used by the East Indians. A bag of coca teaves is almost always found with a mummy. The leaves of this plant, together with the cloth bags in which they were carried and the gourd flasks containing lime may be seen in the collection.

MISCELLANEOUS EXHIBITS.

This gallery contains many exhibits, some of them very important, of which no special mention has been made, since it is believed that the case labels and the guide leaflets attached to the cases will furnish the desired information to the student and visitor. Among these may be mentioned the collection from the West Indies, the musical instruments of the Incas, the case containing a great variety of animal forms in pottery; collections of feather-work from Peru, Bolivia, Paraguay and Brazil, and the collection from Columbia consisting of many objects in pottery, stone and shell.

BIBLIOGRAPHY.

The following books will be found useful to those who wish to study South American Archæology and they may be consulted on application to the librarian of the Museum.

Vega, Garcilasso de la. The Royal Commentaries of Peru. Ed. Rycaut, London, 1688.
Cieza de Leon, Pedro de. Chronicle of Peru, Part I. (Hakluyt Society.) London, 1864.
Andagoya, Pascual de. Narrative of the Proceedings of Pedrarias Davila. (Hakluyt Society.) London, 1865.
Prescott, William H. History of the Conquest of Peru. London, 1847.
Herndon and Gibbon. Exploration of the Valley of the Amazon. Washington, 1853.
Frezier, Monsieur. A Voyage to the South Sea and Along the Coast of Chili and Peru. London, 1717.
Whymper, Edward. Travels Amongst the Great Andes of the Equator. New York, 1892.
Hutchinson, Thomas, Jr. Two Years in Peru, with Explorations of its Antiquities. London, 1873.
Squier, E. G. Incidents of Travels and Explorations in the Land of the Incas. New York, 1877.
Wiener, Charles. Perou et Bolivie. Paris, 1880.
Reiss and Stuebel. The Necropolis of Ancon. Ed. Keane, New York, 1887.
Bæssler, Arthur. Ancient Peruvian Art. New York, 1903.
Stuebel and Uhle. Die Ruinenstätte von Tiahuanaco. Breslau, 1892.
Holmes, William H. Textile Art in its Relation to the Development of Form and Ornament. Annual Report Bureau Amer. Ethnology, 1884–85.
Stuebel, Reiss and Koppel. Südamerikanische Völker. (Alte Zeit.) Berlin, 1889.

The American Museum Journal

Edmund Otis Hovey, *Editor*

Frank M. Chapman,
Louis P. Gratacap, } *Advisory Board*
William K. Gregory,

Subscription, One Dollar per year. Fifteen Cents per copy

A subscription to the Journal is included in the membership fees of all classes of Members of the Museum.

Subscriptions should be addressed to the American Museum Journal, 30 Bolyston St., Cambridge, Mass., or 77th St., and Central Park West, New York City.

The Guide Leaflet Series

of the

AMERICAN MUSEUM OF NATURAL HISTORY

Issued as supplements to The American Museum Journal

For Sale at the Museum

No. 1. **THE BIRD ROCK GROUP.** By Frank M. Chapman, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price*, 10 *cents.*

No. 2. **THE SAGINAW VALLEY COLLECTION.** By Harlan I. Smith, Assistant Curator of Archæology. December, 1901. *Price*, 10 *cents.*

No. 3. **THE HALL OF FOSSIL VERTEBRATES.** By W. D. Matthew, Ph.D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4. **THE COLLECTION OF MINERALS.** By Louis P. Gratacap, A. M., Curator of Mineralogy. Feb., 1902. *Rev. edition, May*, 1904. *Price*, 10 *cents.*

No. 5. **NORTH AMERICAN RUMINANTS.** By J. A. Allen, Ph.D., Curator of Mammalogy and Ornithology. Mar., 1902. *Rev. ed., Feb.*, 1904. 10 *cents.*

No. 6. **THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH**. By George H. Pepper, Assistant in Anthropology. Apr., 1902. *Price, 10 cents.*

No. 7. **THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY**. By William Beutenmüller, Curator of Entomology. May, 1902. *Price, 15 cents.*

No. 8. **THE SEQUOIA**. A Historical Review of Biological Science. By George H. Sherwood, A.M., Assistant Curator. Nov., 1902. *Price, 10 cents.*

No. 9. **THE EVOLUTION OF THE HORSE**. By W. D. Matthew, Ph.D., Associate Curator of Vertebrate Palæontology. Jan., 1903. *Second edition, May, 1905. Price, 10 cents.*

No. 10. **THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY**. By William Beutenmüller, Curator of Entomology. Feb., 1903. *Price, 10 cents.*

No. 11. **THE MUSICAL INSTRUMENTS OF THE INCAS**. By Charles W. Mead, Assistant in Archæology. July, 1903. *Price, 10 cents.*

No. 12. **THE COLLECTION OF FOSSIL VERTEBRATES.** By W. D. Matthew, Ph.D., Associate Curator of Vertebrate Palæontology. Oct., 1903. *Price, 10 cents.*

No. 13. **A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY**. January, 1904. *Price, 15 cents.*

No. 14. **BIRDS' NESTS AND EGGS.** By Frank M. Chapman, Associate Curator of Mammalogy and Ornithology. Apr., 1904. *Reprinted, Feb., 1905. Price, 10 cents.*

No. 15. **PRIMITIVE ART**. July, 1904. *Price, 15 cents.*

No. 16. **THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY**. By William Beutenmüller, Curator of Entomology. Oct., 1904. *Price, 15 cents.*

Reprinted from The American Museum Journal.

No. 17. **THE FOSSIL CARNIVORES, MARSUPIALS, AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY**. By W. D. Matthew, Ph.D., Associate Curator of Vertebrate Palæontology. Jan., 1905. *Price, 15 cents.*

No. 18. **THE MOUNTED SKELETON OF BRONTOSAURUS**. By W. D. Matthew, Ph.D., Associate Curator of Vertebrate Palæontology. Apr., 1905. *Out of print.*

No. 19. **THE REPTILES OF THE VICINITY OF NEW YORK CITY**. By Raymond L. Ditmars, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Price, 15 cents.*

No. 20. **THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY**. By Raymond L. Ditmars, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price, 15 cents.*

No. 21. **THE DEVELOPMENT OF A MOLLUSK**. By B. E. Dahlgren, D.M.D. Jan., 1906. *Price, 10 cents.*

No. 22. **THE BIRDS OF THE VICINITY OF NEW YORK CITY**. By Frank M. Chapman, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price, 15 cents.*

No. 23. **THE SPONGE ALCOVE**. By Roy W. Miner, Assistant Curator of Invertebrate Zoölogy. Oct. 1906. *Price, 10 cents.*

Published as a Separate Series.

No. 24. **PERUVIAN MUMMIES**. By Charles W. Mead, Department of Ethnology. March, 1907. *Price, 10 cents.*

American Museum of Natural History

PIONEERS

OF

AMERICAN SCIENCE

NEW YORK
PUBLISHED BY THE MUSEUM
APRIL, 1907

American Museum of Natural History

Seventy-Seventh Street and Central Park West, New York City

NORTHEAST QUARTER OF FOYER

Showing five of the Marble Busts of Pioneers of American Science.

PIONEERS

OF

AMERICAN SCIENCE

AN ACCOUNT OF THE EXERCISES HELD

AND THE ADDRESSES DELIVERED

AT THE

AMERICAN MUSEUM OF NATURAL HISTORY

DECEMBER 29, 1906

PIONEERS OF AMERICAN SCIENCE.

Saturday, December 29, 1906, was notable in the annals of the Museum, since at 3 o'clock of that day there were held in the large auditorium the ceremonies attending the unveiling of the marble busts which have been installed in the foyer, representing ten of the men who have been foremost in the advancement of science in America. The auditorium was crowded to its full capacity with Members of the Museum and their friends and visiting scientists, and Professor H. F. Osborn, Second Vice-President of the Museum, presided in the absence, due to illness, of Mr. J. Pierpont Morgan, First Vice-President. The exercises began with the singing of the national anthem "America," after which Dr. Hermon C. Bumpus, Director of the Museum, acting for Mr. Morris K. Jesup, addressed the Trustees as follows:

"Thirty-six years ago several men of this city organized to perform three closely-related functions:

1, To establish and maintain a museum of natural history;

2, To encourage and develop the study of the natural sciences;

3, To advance the general knowledge of kindred subjects.

"Of this company, Mr. Morgan was one; a second (Mr. Choate) is he who will receive on behalf of the Honorable Board of Trustees the splendid gift that has brought this congregation of scientists together, and a third is he who for more than twenty-five years, as President, has devoted his time, his thought, his energy, his influence, his means, his health, not for the mere naked fulfilment of the terms of the Articles of Incorporation, but for the up-building of an institution that would excite civic pride, for the molding of forces that would result in educational power, for the combination of material that would develop character and for the general exploration of the secrets of Nature, be they hidden in the remote regions of Siberia, in the unknown land and waters of the North, in the ancient monuments of the South or the outcropping foundations of the continent in the West.

"To what extent the sympathetic union of these three men with other earnest workers in a common cause has been successful in the establishment and maintenance of a museum of natural history, none are better able to judge than the members of the various scientific and educational organizations,— the guests that honor the Museum by their presence

this afternoon. Many of our guests today are frequent students of the Museum's collections, frequent readers of the Museum's publications and frequent users of the Museum's library.

"But it is the effort to fulfill the terms of the second paragraph of the Articles of Incorporation — the paragraph that refers to the encouragement and development of the Study of the Natural Sciences, that provides for the aggressive invasion of the unknown and for the encouragement of those who enter the unknown for search and research — it is the effort to fulfill these terms that has characterized the administration of this institution and made it something different from a mere museum.

"The prime incentive for the pursuit of science is doubtless indiscoverably hidden among those forces that direct the growth and activities of the human body, but the strongest secondary incentive is appreciation — commendation. An institution that is pledged to the encouragement and development of the natural sciences ought certainly to appreciate and commend those who have conspicuously devoted themselves to the pursuit of science. It is in response to this feeling of obligation and with the hope that such recognition at this time might act as a helpful incentive to those attending the important scientific meetings now being held in New York, that these exercises have been arranged.

"In an adjoining hall, as we leave this auditorium, we shall find unveiled ten portraits of the pioneers of American science, the work of one of America's leading sculptors, Mr. William Couper.

"It is this series of busts that I have the honor, on behalf of Mr. Morris K. Jesup, to present to the Trustees for permanent exhibition in this Museum, and with it may I convey the desire that they may serve as a token of the donor's esteem for all who have devoted and are devoting themselves to the development of science, and also that all entering this institution may feel that the study of the natural sciences is encouraged and developed, not by immediate results alone, but also in the proper recognition of those who have unselfishly labored for its advancement."

In accepting the gift, Hon. Joseph H. Choate said in behalf of the Board of Trustees:

"As you have already heard, it is only in my accidental capacity of survivor that I have the honor of appearing here today to receive this gift. Mr. Morgan could not come, Mr. Jesup could not accept

his own gift, — he knows how much better and more delightful it is to give than to receive, — and so I stand here for a moment on behalf of my fellow trustees, to receive this splendid donation.

"If this were Mr. Jesup's only gift to the Museum, it ought to place him among the immortals. To place in our vestibule, at the entrance of these halls of science, the busts of these great pioneers and masters, to place them here so that the future generations of New York and of America may become familiar with their features would be in itself a very great and valuable gift. Ever since the foundation of this Museum thirty-seven years ago, he has been enriching and endowing it with wonderful gifts.

"Most of you are perfectly familiar with the chief of these, — the Jesup Collection of Woods, containing the wood of every tree known to be existing in North America, a perfectly unique collection which cannot anywhere be repeated; the collections that were brought by the Jesup North Pacific Expedition from the shores of British Columbia, Alaska and Asia are also unique in their way; and in the Hall of Vertebrate Palæontology a large portion of that wonderful exhibit is from his generous hands. Even now, today, he is fitting out for our benefit an expedition for the exploration of fossils in northern Egypt, and I am sure that when Professor Osborn, who is to head the expedition, returns next spring, he will come 'bearing his sheaves with him,' in the form of the fossil remains of the ancestral elephant, which he will find somewhere between the mouth of the Nile and the Nubian Desert — exactly where I cannot tell, but he, at this moment, with his prophetic vision could put his finger upon the very spot.

"This Museum, if you will notice the date, was born in the Dark Ages of the City of New York — in 1869 — when the public enemy was in possession of the city and of its treasury. It was a gloomy day for the foundation of such an institution. I believe it was about that time that one board of public officials, catching a strange ray of light for that dark time, had employed the celebrated Dr. Hawkins to prepare models of the vast fossil mammals for exhibition to the people. They gave him a house in Central Park, where he set to work on that great study. By and by, there came in another set of public officials who were as antediluvian as the fossils themselves, and they broke his models all up and sent the doctor on his way not rejoicing at all.

"We never dared in those days to hope or expect help from the

City for such an institution as this, but light soon dawned upon us, and gradually year by year the City Officials and the people of the City began to find that this was a great educational institution maintained for the benefit of the people. But it was hard struggling in those early days. Despair followed anxiety, and our Trustees knew not which way to turn. But when Mr. Jesup, twenty-six years ago, took the presidency of this body, he found that certain fossils still lingered in the Board of Trustees, and actually breathed into us the breath of life. He has kept us alive ever since, and every year this Museum has exhibited new energy and success, and more than three fourths of it is due to his generous gifts and his inspiring presence.

"He has given us something far better and grander than material assistance, liberal as he has been with that. He has given us twenty-six of the best years of his life, devoted with untiring generosity to the success of this enterprise. It is also to be remembered to the great credit of Mr. Jesup that it was during his administration that the Museun took one significant step forward, which we had long been hesitating to do — I mean the opening of the Museum to the public on Sundays. It was the best advance we ever made. We found that we could do our duty to the church in the morning and come here with equally reverent minds in the afternoon to study these collections and look through Nature up to Nature's God, and the people found that out too.

"And so with grateful hearts the Trustees accept this last and noble offering, and I am sure you will all with one voice join with me in saying — God bless the noble donor."

After Mr. Choate's address brief memorials of the men of science whose portraits have been selected for the foyer, were delivered in accordance with the following program:

Benjamin Franklin, by Dr. S. Weir Mitchell of Philadelphia;

Alexander von Humboldt, by His Excellency, Baron Speck von Sternburg, German Ambassador. (Read by Major T. von Körner, Military Attaché of the Embassy);

John James Audubon, by Dr. C. Hart Merriam, Chief, U. S. Biological Survey, Washington, D. C.;

John Torrey, by Dr. Nathaniel L. Britton, Director in chief, New York Botanical Garden, New York City;

Joseph Henry, by Dr. Robert S. Woodward, President, Carnegie Institution, Washington, D. C.;

Louis Agassiz. Letters were read from the Rev. Edward Everett Hale, an

BENJAMIN FRANKLIN

Born, Boston, January 17, 1706.
Died, Philadelphia, April 17, 1790.

Physicist, author, editor, philosopher

Demonstrated the identity of lightning and electricity

intimate personal friend of Professor Agassiz, and Professor F. W. Putnam, of Harvard University, and remarks were made by Professor Addisson E. Verrill of Yale University and Dr. C. D. Walcott, Director of the U. S. Geological Survey;

James Dwight Dana, by Dr. Arthur Twining Hadley, President, Yale University, New Haven, Conn.;

Spencer Fullerton Baird, by Dr. Hugh M. Smith, Deputy Commissioner, Bureau of Fisheries, Washington, D. C.;

Joseph Leidy, by Professor William Keith Brooks, Johns Hopkins University, Baltimore, Md.;

Edward Drinker Cope, by Dr. Henry Fairfield Osborn, Curator, Department of Vertebrate Palæontology, American Museum of Natural History.

The addresses as delivered were as follows:

BENJAMIN FRANKLIN.

By S. Weir Mitchell.

We are here, as I understand, to unveil memorial busts of Americans distinguished in science, and I am honored by the privilege of speaking of Benjamin Franklin. This man, the father of American Science, was possessed of mental gifts unequalled in his day. Even yet he holds the highest place in the intellectual peerage of a land, where, in his time, men had few interests which were not material or political. But no man entirely escapes the despotic influences of his period. Thus in every life there are unfulfilled possibilities, and so it was that, paraphrasing Goldsmith, we may say that Franklin to country gave up what was meant for mankind, when with deep regret he resigned in middle life all hope of whole-souled devotion to science. When most productive, his scientific fertility was the more remarkable because of the other forms of dutiful activity which, in a life that knew no rest, left small leisure for those hours of quiet thought without which science is unfruitful of result.

There is a Hall of Fame not built by the hand of man. It is the memory of mankind. In many of its galleries this man's bust could with justice be placed. Diplomacy would claim him as of her greatest. For him would be the laurel of administrative wisdom. Among statesmen he would be welcomed. Who of the masters of English prose shall in that hall of fame be more secure of grateful remembrance, and who more certain of a place among men of science?

As an investigator of Nature and of Nature's laws he is materially represented here by right of eminent achievement. Let us as men of science feel proud that Franklin's fame as a philosopher did much to win for Franklin the diplomatist such useful consideration and respect as led to final success.

Many of those you honor today had moral and temperamental peculiarities which more or less influenced their lives and are common to men of science. Most of them cared little about making money; still less about keeping it. Franklin on the contrary dreaded poverty; was careful in business, made fruitful investments and died rich; nevertheless like the typical man of science he refused to make money out of his discoveries, or to protect his inventions by patents. In him the man of science, unselfish, free from money greed, seemed to exist apart from all those other men who went to the making of the many-minded Franklin. In another way he was singularly unlike such typical men of science as Henry, in physics, and Leidy, in natural history. When Franklin made a discovery, his next thought was as to what practical use it could be put. If he made some novel observation of nature, he asked himself at once how he could make it serve his fellow men. The great reapers of the harvest of truth commonly leave the inventor to make practical use of their unregarded thought.

Leaving the wide land to do justice to Franklin, the model citizen and great diplomatist, here we crown with the assured verdict of posterity Franklin, the man of pure science. Here we welcome him to this goodly fellowship of those who communed with Nature and read the secrets of the Almighty Maker.

ALEXANDER VON HUMBOLDT.

Mr. President, Gentlemen:

His Excellency, the German Ambassador, whom heavy official duties retain at Washington, has requested me to represent him on this occasion and to express to you his hearty congratulations on this event on which through Mr. Jesup's generous munificence this commemorative tribute is paid to the world's great masters of science, a day on which this magnificent museum of natural history has received a donation which will awake a solemn sense of reverence and make this abode


HUMBOLDT

ALEXANDER VON HUMBOLDT

Born, Berlin, September 14, 1769
Died, Berlin, May 6, 1859

Geographer, traveler, philosopher

Described the surface features and the geological structure of many lands

henceforth a temple of devotion to the founders and promoters of natural science.

Whoever honors the memory of great men, honors science and honors himself, and so the Ambassador has asked me to convey to the generous donor, the tireless promoter of science, Mr. Jesup, the expression of his sincerest admiration and of his heartfelt thanks for the honor which will be conferred also upon the great German scholar, Alexander von Humboldt.

In this immortal man, whose bust you have gathered to unveil, the world reveres its greatest master since the days of Aristotle. His genius covered all that man has ever thought, done and observed in nature. There is no branch of human knowledge into which his mind did not penetrate. His "Cosmos," that marvellous monument of meditation and research, is a new book of Genesis in which the Universe mirrors itself in all its vastness and minuteness "from the nebulæ of the stars" — to use his own words — "to the geographical distribution of mosses on granite rocks."

By his wonderful talent of research, by his almost superhuman power to divine eternal laws, this great interpreter of science taught mankind how to read the book of nature, how to understand its great mysteries. The series of sciences, originated by this mighty genius is, as well as the other manifold branches of science developed by him, sufficiently known to all.

In all his investigations his ultimate aim was to bring theory into practical relation with life. Thus he not only elevated the standard of culture of the whole world by many steps, but he also became from a practical point of view the benefactor of mankind in many branches of common life,— as trade, commerce, navigation.

He taught us how to conceive the beauty and sublimity of nature in its every form and motion. His studies are not a matter merely of memory and of dry meditation, to him Nature was rather the inexhaustible source of pure and deep enjoyment, by which the heart is purified and ennobled and men are brought nearer to perfection.

It is not necessary to give you a more detailed picture of his life. All this is so well known and so dear to the whole learned world of America; for never has a foreign scholar been more honored in this country than Alexander von Humboldt. To realize this we need only recall the celebrations which took place in his memory throughout all

America both at the time of his death and on the occasion of the centennial anniversary of his birth.

Humboldt devoted five years of his life to scientific investigations in South and Central America, in Mexico and in Cuba. He ascertained the course of the greatest rivers; he climbed the summits of mountains where man's foot had never trod before; he studied vegetation, astronomical and meteorological phenomena, gathered specimens of all natural products and a great deal of historical information about the early population of these parts of the New World. It was he that drew the first accurate maps of these regions. With almost prophetic forecast of the needs of generations to come, he examined the Isthmus of Panama and considered carefully the possibility of establishing there an interoceanic waterway.

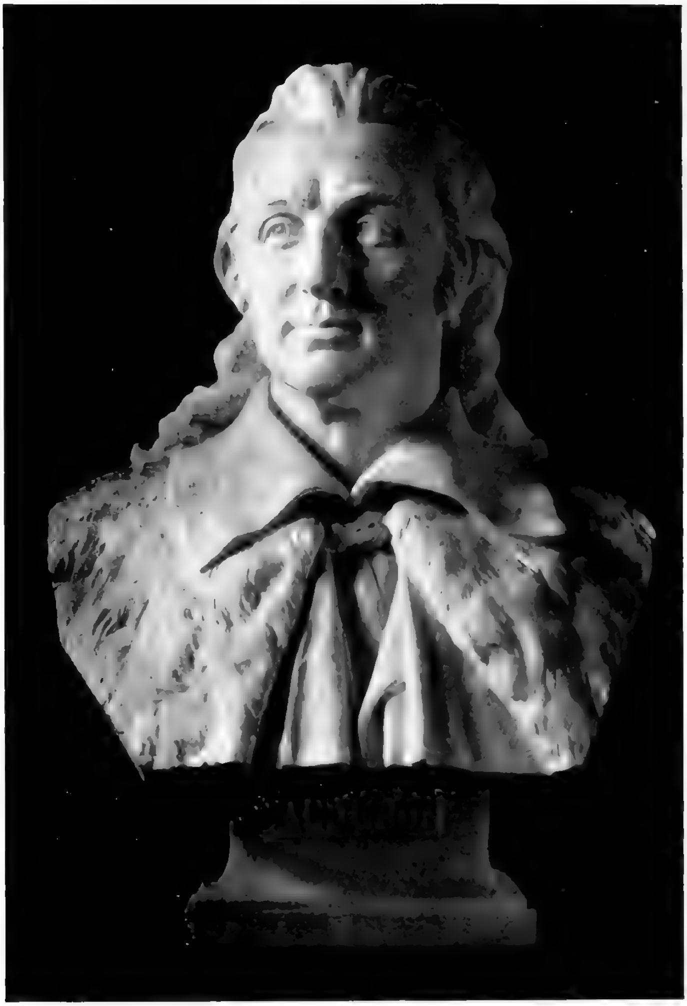
It is well known how great an interest Alexander von Humboldt took in the United States. Indeed, so strongly was he attracted by the problems of the new-born Republic that putting aside even his habitual scientific occupations, he devoted himself entirely for some months to the study of the American people and the institutions of this country.

Finally, the great scientist, he whom people call the scientific discoverer of America, returned to his country, carrying with him a vast store of intellectual and material treasures of science. So abundant were the results, reaped from his expeditions, that he needed the coöperation of the best scholars of his time to compile that great mass of material, and to place it in proper shape and form.

Throughout his long and industrious life, Alexander von Humboldt ever retained his love for and devotion to the country where his great field of labor lay, and for its people with whom he always felt closely connected by his love for freedom in thought and for liberty. It is a well-known fact that in his later days of all the foreigners, who knocked at his door, no one was more heartily welcomed than the American citizen.

The benefits of his investigations in America returned to that country in the course of time. No wonder that her people recognize him as their benefactor. Another great man, whose monument will be unveiled today, and most deservedly placed beside the one of Alexander von Humboldt, Louis Agassiz, says of him:

"To what degree we Americans are indebted to von Humboldt, no



of illustrated volumes on the Birds [1] and Quadrupeds [2] of North America, his Synopsis of Birds,[3] and the Journals [4] of his expeditions to Labrador and to the Missouri and Yellowstone Rivers.

The preparation and publication of his elephant folio atlases of life-size colored plates of birds, begun in 1827 and completed in 1838, with the accompanying volumes of text (the "Ornithological Biography," 1831-1839), was a colossal task. But no sooner was it accomplished than an equally sumptuous work on the mammals was undertaken, and, with the assistance of Bachman, likewise carried to a successful termination. For more than three-quarters of a century the splendid paintings which adorn these works, and which for spirit and vigor are still unsurpassed, have been the admiration of the world.

In addition to his more pretentious works, Audubon wrote a number of minor articles and papers and left a series of "Journals," since published by his grand-daughter, Miss Maria R. Audubon. The Journals are full to overflowing with observations of value to the naturalist and, along with the entertaining "Episodes," throw a flood of light on contemporary customs and events. Incidentally, they are by no means to be lost sight of by the historian.

In searching for material for his books Audubon traveled thousands of miles afoot in various parts of the eastern states, from Maine to Louisiana; he also visited Texas, Florida and Canada; crossed the ocean several times, and conducted expeditions to far-away Labrador and the then remote Missouri and Yellowstone Rivers. When we remember the limited facilities for travel in his day, the scarcity of railroads, steamboats and other conveniences, we are better prepared to appreciate the zeal, determination and energy necessary to accomplish his self-imposed task.

That it was possible for one man to do so much excellent field work, to write so many meritorious volumes and to paint such a multitude

[1] *The Birds of America*, 4 atlases, double elephant folio colored plates. London, 1827–1838; Ornithological Biography, an account of the habits of the birds of the United States. 5 vols. Royal 8vo, Edinburgh, 1831–1839.

[2] *The Quadrupeds of North America* by John James Audubon and Rev. John Bachman. 3 vols. Royal 8vo text, and elephant folio atlas of colored plates. New York, 1846–1854.

[3] *Synopsis of Birds of North America.* Edinburgh & London, 1839.

[4] *Audubon and his Journals* by Maria R. Audubon. 2 vols. 8vo. New York, 1897.

JOHN TORREY

Born, New York, August 15, 1796
Died, New York, March 10, 1873

Botanist, chemist

One of the founders of botanical science in the United States

of remarkable pictures must be attributed in no small part to his rare physical strength, for do not intellectual and physical vigor usually go hand-in-hand and beget power of achievement? Audubon was noted for these qualities. As a worker he was rapid, absorbed and ardent; he began at daylight and labored continuously till night, averaging fourteen hours a day, allowing, it is said, only four hours for sleep.

In American ornithology, in which he holds so illustrious a place, it was not his privilege to be in the strict sense a pioneer, for before him were Vieillot, Wilson and Bonaparte; and contemporaneous with him were Richardson, Nuttall, Maximilian Prince of Wied and a score of lesser and younger lights some of whom were destined to shine in the near future.

Audubon was no closet naturalist — the technicalities of the profession he left to others — but as a field naturalist he was at his best and had few equals. He was a born woodsman, a lover of wild nature in the fullest sense, a keen observer and an accurate recorder. In addition he possessed the rare gift of instilling into his writings the freshness of nature and the vivacity and enthusiasm of his own personality.

His influence was not confined to devotees of the natural sciences, for in his writings and paintings, and in his personal contact with men of affairs both in this country and abroad, he exhaled the freshness, the vigor, the spirit of freedom and progress of America, and who shall attempt to measure the value of this influence to our young republic?

Audubon's preëminence is due not alone to his skill as a painter of birds and mammals, or to the magnitude of his contributions to science, but also to the charm and genius of his personality, a personality that profoundly impressed his contemporaries, and which, by means of his biographies and journals, it is still our privilege to enjoy. His was a type now rarely met, combining the grace and culture of the Frenchman with the candor, patience and earnestness of purpose of the American. There was about him a certain poetic picturesqueness and a rare charm of manner that drew people to him and enlisted them in his work. His friend, Dr. Bachman of Charleston, tells us that it was considered a privilege to give to Audubon what no one else could buy. His personal qualities and characteristics appear in some of his minor papers, notably the essays entitled "Episodes." These serve to reveal, perhaps better than his more formal writings, the keenness of his insight, the kindness of his heart, the poetry of his nature, the power of his imagination and the vigor and versatility of his intellect.

JOHN TORREY.

By Nathaniel L. Britton.

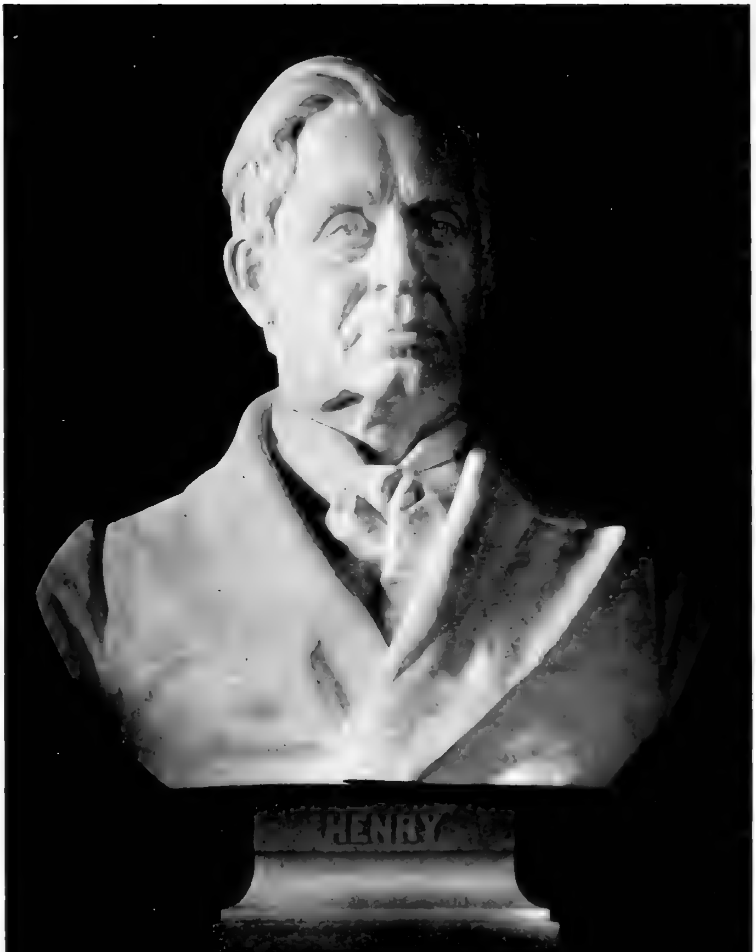
As a pioneer of American botany, John Torrey naturally finds a place among the men whose works we gladly celebrate today in this grand institution developed in the city where he was born; where he resided the greater part of his life, and where he died. Today's recognition of Torrey as a master of botanical science, is therefore peculiarly appropriate in New York, where he is already commemorated by the society which bears his name; by the professorship in Columbia University named in his honor, and by his botanical collections and library deposited by Columbia University at the New York Botanical Garden.

Dr. Torrey was born August 15, 1796, and died March 10, 1873, nearly thirty-four years ago; the pleasure of his personal acquaintance is therefore known to but few persons now living. We have abundant evidence, however, that he was honored and beloved to a degree experienced by but few; righteousness was instinctive in him; aid to others was his pleasure; he was tolerant and progressive, and his genial presence was a delight to his associates.

He was educated for the profession of medicine, graduating from the College of Physicians and Surgeons in 1818, but he soon abandoned it and in 1824 became professor of chemistry at West Point; after three years service there, he was elected professor of chemistry and botany in the College of Physicians and Surgeons, a position which he held for nearly thirty years, during part of this period lecturing on chemistry also at Princeton: he was also United States assayer in New York from 1854 until his death.

Dr. Torrey's attention was directed to botany during his youthful association with Professor Amos Eaton, and his interest in that science was subsequently stimulated during his medical studies by the lectures of Professor David Hosack. It early became his favorite study, and, notwithstanding his noteworthy services to chemistry, his fame rests on his botanical researches, although they were accomplished during his hours of rest and recreation, — largely during the night.

His botanical publications began in 1819 with "A Catalogue of Plants Growing Spontaneously within Thirty Miles of the City of New York," published by the Lyceum of Natural History, now the New York Acad-


HENRY

JOSEPH HENRY

Born, Albany, N. Y., December 17, 1797
Died, Washington, D. C., May 13, 1878

Physicist

Noted for his investigations in electromagnetism
First secretary of the Smithsonian Institution

emy of Sciences, and were completed the year after his death in the "Phanerogamia of Pacific North America," in Vol. 17 of the Report of the United States Exploring Expedition. His contributions to botany include more than forty titles, many of them volumes requiring years of patient study; they throw a flood of light on the plants of North America, and form a grand contribution to knowledge. His collections, on which these researches are based, were annotated and arranged by him with scrupulous care and exactness, and are treasured as among the most important of all scientific material in America.

JOSEPH HENRY.

By Robert S. Woodward.

This time, one hundred years ago, Joseph Henry, whose name and fame we honor today, was a lad seven years of age. He was born at Albany, New York, of Scotch parentage, his grand parents on both sides having come from Scotland in the same ship to the Colony of New York, in 1775.

Doubtless he had himself in mind when in his mature years he affirmed that "The future character of a child, and that of a man also, is in most cases formed probably before the age of seven years." At any rate, he found himself early, for at the age of sixteen he had determined to devote his life to the acquisition of knowledge. Thus he became, in turn, student; teacher; civil engineer in the service of his native State; professor of mathematics and natural philosophy in the Albany Academy; professor of natural philosophy in the College of New Jersey — now Princeton University — and a pioneer investigator and discoverer of the first order before he was thirty-three years of age.

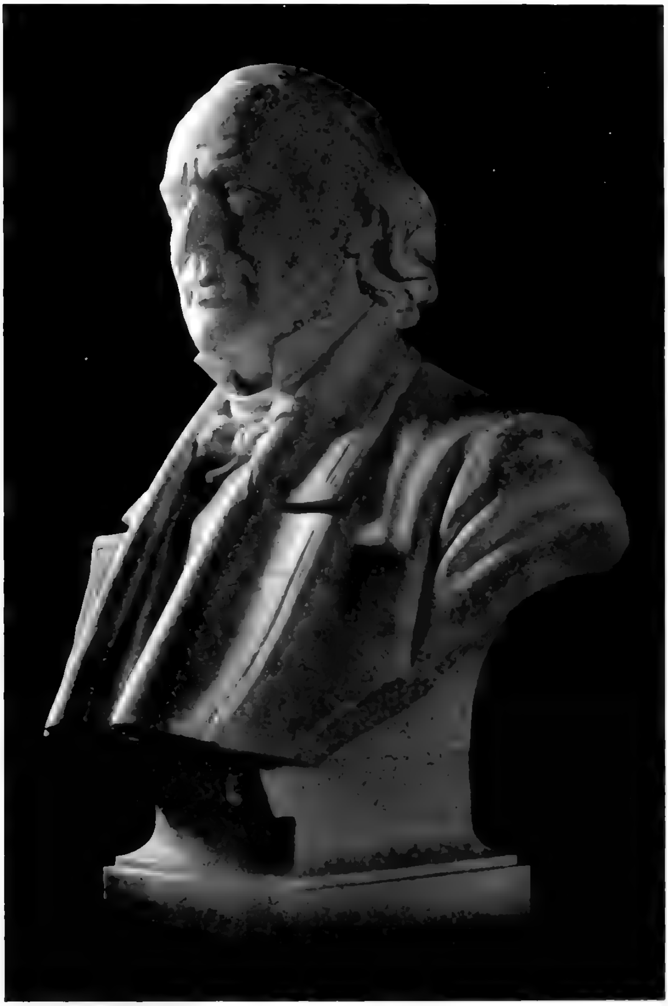
His inventions and discoveries in electromagnetism especially are of prime importance. They include the inventions of the electromagnetic telegraph and the electromagnetic engine and the discovery of many of the recondite facts and principles of electromagnetic science.

From the age of thirty-three, when he took up the work of his professorship at Princeton, till the age of forty-seven, when he was called to the post of Secretary of the Smithsonian Institution, he pursued his original investigations with untiring zeal and with consummate experi-

mental skill and philosophic insight. It was during this period that Henry and Faraday laid the foundations for the recent wonderful developments of electromagnetic science. The breadth as well as the depth of Henry's learning is indicated by the fact that he found time during this busy period for excursions and for lectures in the fields of architecture, astronomy, chemistry, geology, meteorology, and mineralogy in addition to his lectures and researches in physics.

He was a man rich in experience and ripe in knowledge when, in 1846, he assumed the administrative duties implied by the bequest of James Smithson, "To found at Washington, under the name of the Smithsonian Institution an Establishment for the increase and diffusion of knowledge among men." Thenceforth, for thirty-two years, until his death in 1878, he devoted his life to the public service, not alone of our own country, but of the entire civilized world. In this work he manifested the same creative capacity that had distinguished his earlier career in the domain of natural philosophy. He became an organizer and a leader of men. To his wise foresight we owe not only the beneficent achievements of the Smithsonian Institution itself, but also, in large degree, the correspondingly beneficent achievements of the Naval Observatory, the Coast and Geodetic Survey, the Weather Bureau, the Geological Survey, the Bureau of Fisheries and the Bureau of American Ethnology; for to Henry, more than to any other man, must be attributed the rise and the growth in America of the present public appreciation of the scientific work carried on by governmental aid.

We may lament, with John Tyndall, that so brilliant an investigator and discoverer as Henry should have been sacrificed to become so able an administrator. And American devotees to mathematico-physical science may be pardoned for entertaining an elegiac regret that Henry as a pioneer in the fields of electromagnetism did not have the aid of a penetrating mathematical genius, as Faraday had his Maxwell. But posterity, just in its estimates towards all the world, will recognize in Henry, as we have recognized in our earlier hero, Benjamin Franklin, a many-sided man — a profound student of Nature; a teacher whose moral and intellectual presence pointed straight to the goal of truth; an inventor who dedicated his inventions immediately to the public good; a discoverer of the permanent laws which reign in the Sphinx-like realm of physical phenomena; an administrator and organizer of large enterprises which have yielded a rich fruitage for the enlighten-



LOUIS AGASSIZ

Born, Motier, Switzerland, May 28, 1807
Died, Cambridge, Mass., December 14 1873

Zoölogist, ichthyologist

Celebrated lecturer and writer on natural history in general

ment and for the melioration of mankind; a leader of men devoted to the progress of science; a patriot, friend and counsellor of Abraham Lincoln in the darker days of the Republic — in short, an exemplar for his race, a man whose purity and nobility are here fitly symbolized in enduring marble for our instruction and guidance and for the instruction and the guidance of our successors in the centuries to come.

LOUIS AGASSIZ.

A Letter from Edward E. Hale.

Read by Addison E. Verrill, who added interesting personal reminiscences of Agassiz.

Washington, D. C., December 8, 1906.

I think that the first time when I ever saw Agassiz was at one of his own lectures early in his American life. This was a description of his ascent of the Jungfrau. I think it was wholly extempore, and, though he was new in his knowledge of English, it was idiomatic and thoroughly intelligible. At the end, as he described the last climb, hand and foot, by which, as it seems, men come to the little triangular plane, only three feet across, which makes the summit, he quickened our enthusiasm by describing the physical struggle by which he lifted himself so that he could stand on this little three-foot table. He said, "one by one we stood there, and looked down into Swisserland." He bowed and retired.

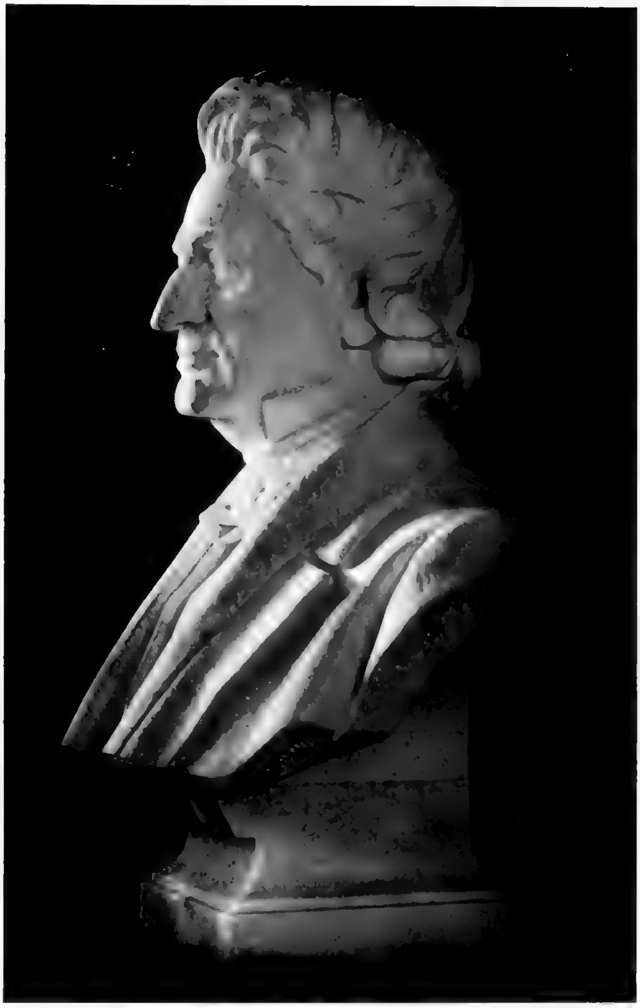
I know I said at once that Mr. Lowell, of our Lowell Institute, who had "imported Agassiz," (that is James Lowell's phrase) might have said before the audience left the hall, "You will see, ladies and gentlemen, that we are able to present to you the finest specimen yet discovered of the genus *homo* of the species *intelligens*."

And looking back half a century, on those very first years of his life in America, I think it is fair to say that wherever he went he awakened that sort of personal enthusiasm. And he went everywhere. He was made a professor in Harvard College in 1848. But he never thought of confining himself to any conventional theory of a college professor's work. He was not in the least afraid of making science popular. He

flung himself into any and every enterprise by which he could quicken the life of the common schools, and in forty different ways he created a new class of men and women. Naturalists showed themselves on the right hand and on the left. I have seen him address an audience of five hundred people, not twenty of whom when they entered the hall thought they had anything to do with the study of Nature. And when after his address they left the hall, all of the five hundred were determined to keep their eyes open and to study Nature as she is. From that year 1848, you may trace a steady advance in Nature Study in the New England schools.

That is to say, that his distinction is that of an educator quite as much as it is that of a naturalist. In 1888, Lowell said, in his quatermillennial address at Harvard College, that the College had trained no great educator, "for we imported Agassiz." A great educator he truly was.

When Agassiz was appointed Professor he was forty-one years old. In my first personal conversation with him he told me a story which may not have got into print, of his own physical strength. He spoke as if it were then an old experience to him. Whether he were twenty-five or thirty-five when it happened, it shows how admirable was his training and his physical constitution. He had been with a party of friends somewhere in eastern Switzerland. They were travelling in their carriages; he was on foot. They parted with the understanding that they were to meet in the Tyrol, at the city of Innsbruck. Accordingly the next morning, Agassiz rose early and started through the mountains by this valley and that, as the compass might direct or his previous knowledge of the region. He did not mean to stop for study and they did not. But he had no special plan as to which hamlet or cottage should cover him at night. Before sundown he came in sight of a larger town than he expected to see, in the distance, and calling a mountaineer, he asked him what that place was. The man said it was Innsbruck. Agassiz said that that could not be so. The man replied with a jeer that he had lived there twenty years, and had always been told that that was the name of the place, but he supposed Agassiz knew better than he did. Accordingly Agassiz determined that he would sleep there and did so. The distance was somewhere near seventy miles. I know it gave me the impression of a walk through the valley passes at the rate of four miles an hour, for sixteen or seventeen hours.



JAMES DWIGHT DANA

Born, Utica, N. Y., February 12, 1813
Died, New Haven, Conn., April 14, 1895

Geologist, mineralogist, zoölogist

One of the principal founders of geological science in the United States

In later life Agassiz made to us some prophecies in which we may trace his enjoyment of the finest physical health and strength. Health and strength indeed belonged to everything which he said and did.

Among other things he said, twenty-five years ago, that the last years of our century, — the twentieth, would see a population of a hundred million of people in the valleys of the upper Amazon. I like to keep in memory this brave prophecy, because I am sure it will come true.

From a Letter from Professor F. W. Putnam.

Read by Charles D. Walcott, who gave also his own token of appreciation of Agassiz.

"It is a real grief to me that I cannot take this opportunity to offer tribute to my beloved and honored teacher, — Louis Agassiz. What a pleasure it would be to me to say a few words of appreciation of that great and good man. Not alone to speak of his scientific achievements, which are known the world over, but, from my intimate association with the great naturalist, to tell of all he did, fifty years ago, for the advancement and encouragement of the study of natural history; to picture his inspiring method of teaching; and to dwell on his goodness of heart, his genial magnetic personality and his wonderful power of winning the life-long devotion of his students."

JAMES DWIGHT DANA.

By Arthur T. Hadley.

It was my privilege to know James Dwight Dana intimately during my early years. To boyhood's imagination his figure typified the man of science; his life personified the spirit of scientific discovery. Wider acquaintance with the world has not in any way dimmed the brightness of that early impression.

The services of the geologist are today recognized by every one, and sought by all who can afford them. If he would make a voyage of exploration and discovery, the resources of the world of finance are

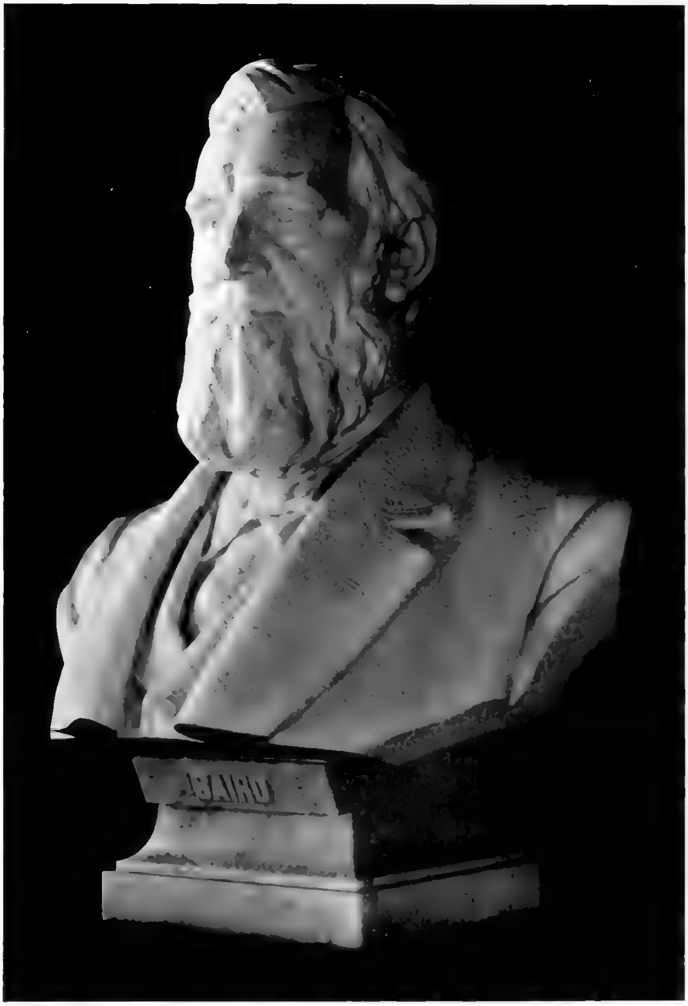
placed at his disposal. No such aids were given two generations ago. In Dana's journeyings he had to surmount hardship and peril, and to meet the coldness of those who knew not the value of the quest which he pursued. He and his contemporaries were like the knights errant of chivalry, devoting their lives to an ideal. They were men of faith, who combined the spirit of the missionary and the inspiration of the poet with the clear vision of the observer.

The largeness of Dana's work was commensurate with the largeness of his inspiration. It fell to his lot not only to fill out many pages of the record of the building of the world, as written in the fossil life of America, but to show in important ways the methods by which that building was accomplished. His creative brain never rested content with mere description of facts. He had the more distinctively modern impulse to reconstruct the process by which those facts were brought to pass. From his observations of coral islands in the various stages of their growth he deduced a geologic principle of world-wide importance. It is this characteristic which makes the great modern German school of geologists headed by Suess look to Dana as their precursor, more than to any other man of his generation.

He was not content with the work of discovery alone. The teaching spirit was strong within him. The pioneers in science needed editors and expositors who should make their results known. In each of these capacities Dana's achievements were phenomenal. Of his work as an editor he has left the files of the American Journal of Science as a monument. Of his work as an expositor those who have heard his lectures and attended his class room exercises can speak with unbounded enthusiasm. He was one of the rare men who by presence and voice and manner could bring the truths and ideals of science home even to those pupils with whom scientific study could never be more than an incident in their lives.

But above all his works and above all his qualities stands the figure of Dana himself — more than an explorer, more than a discoverer, more than a teacher; his countenance, as it were, illuminated by a touch of the light of a new day for which the world was being prepared.

> "His life was gentle; and the elements
> So mixed in him that Nature might stand forth
> And say to all the world, 'This was a man.'"


BAIRD

SPENCER FULLERTON BAIRD

Born, Reading, Pa., February 3, 1823
Died, Woods Holl, Mass., August 19, 1887

Zoölogist

Noted for his work in the Smithsonian Institution and the United States Fish Commission

SPENCER FULLERTON BAIRD.

By Hugh M. Smith.

The life, the character, the work of Spencer Fullerton Baird entitle him to recognition in any assemblage and on any occasion where honor is paid to those who have been their country's benefactors through illustrious achievements in science.

Developing a taste for scientific pursuits at a very early age, and confirmed in those pursuits through the influence of friendships with Agassiz, Audubon, Dana and other leading scientists of the time, Baird was selected as assistant secretary of the Smithsonian Institution when only twenty-seven years old, and there entered on a career devoted to the promotion, diffusion and application of scientific knowledge among men, and marked by dignity, sound judgment, fidelity to duty, versatility and general usefulness.

In the many phases of his intellectual development he resembled Franklin and Cope; in the multiplicity of his public duties and in the diversity of the scientific accomplishments in which he attained eminence he had few equals; in founding, organizing and simultaneously directing a number of great national scientific enterprises he was unique among those whose memory is here extolled today.

To render an adequate account of the branches of scientific endeavor in which he achieved prominence, benefited his own and future generations and added to his country's renown, one would need to be an ornithologist, a mammalogist, an ichthyologist, a herpetologist, an invertebrate zoölogist, an anthropologist, a botanist, a geologist, a palæontologist, a deep-sea explorer, a fishery expert, a fish-culturist, an active administrator of scientific institutions and an adviser of the federal government in scientific affairs,—for Baird was all these and more.

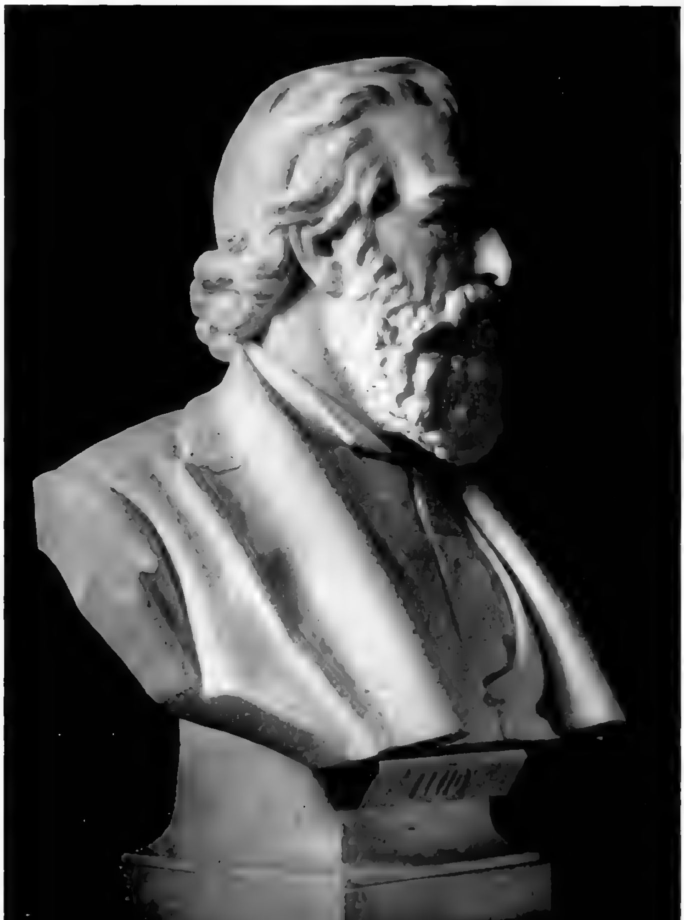
We freely acknowledge today the debt that science owed Baird alive and now owes his memory, especially for his inestimable services as assistant secretary and later as secretary of the Smithsonian Institution, as director of the National Museum and as head of the Commission of Fish and Fisheries. Among all the establishments with which he was connected, this last was preëminently and peculiarly his own.

It was conceived by him and created for him, and it would almost appear that he was created for it, for certainly no other person of his day and generation was so admirably fitted for the task of organizing this bureau and of executing the duties that grew out of its functions as successively enlarged by Congress. Insisting on scientific investigations and knowledge as the essential basis for all current and prospective utilitarian work, he drew around him a corps of eminent biologists and physicists; he established laboratories; he laid plans for the systematic study of our interior and coastal waters; he had vessels built that were especially designed and equipped for exploration of the seas. While he thus inaugurated operations which have been of lasting benefit to the fisheries, at the same time he became the foremost promoter and exponent of marine research; and the knowledge we today possess of oceanic biology and physics is directly or indirectly due to Baird more than to any other person. The rapid development of piscicultural science under his guidance gave to the United States the foremost place among the nations in maintaining and increasing the aquatic food supply by artificial means; and it was no perfunctory tribute when in 1880, at the International Fishery Exhibition held in Berlin, Emperor William awarded the grand prize to Baird as "the first fish-culturist in the world."

The spirit of Baird influences the Bureau of Fisheries today, as it does all the other institutions with which he was associated; and since his death nearly twenty years ago, the good that has been accomplished in the interest of fish culture and the fishing industry, and in the conduct and encouragement of scientific work, has been in consequence of the foundations he laid, the policy he enunciated and the example he set.

But conspicuous as were his services to science and mankind; faithful and unselfish as was his devotion to the executive responsibilities imposed on him; beautiful as was his personal character, I conceive that his most enduring fame may result from the enthusiasm with which he inspired others, and the encouragement and opportunity that he afforded to all earnest workers. The recipients of his aid can be numbered by hundreds, and many of them are today his worthy successors in various fields; and their places in turn will gradually be taken by a vast number of men and women who will perpetuate his memory by efficiently and reverently continuing his work.

This evidence of the donor's beneficence is a noble and impressive



JOSEPH LEIDY

Born, Philadelphia, September 9, 1823
Died, Philadelphia, April 30, 1891

Anatomist, zoölogist, palæontologist

Noted for pioneer work among the fossil vertebrates of western United States

memorial of one who merited his country's profoundest gratitude; but the bust signifies something more, for it is a recognition of that zeal, fidelity, self-sacrifice, intelligence and strength in the American character so preëminently typified by Spencer Fullerton Baird.

JOSEPH LEIDY.

By William Keith Brooks.

Joseph Leidy was born in Philadelphia; there he passed his three score years and ten, and there he died. For forty-five years he was an officer in the Philadelphia Academy of Natural Science, and for forty years a professor in the University of Pennsylvania. His character was simple and earnest, and he had such a modest opinion of his talents and of his work, that the honors and rewards that began to come to him in his younger days, from learned societies in all parts of the world, and continued to come for the rest of his life, were an unfailing surprise to him.

His knowledge of anatomy and zoölogy and botany and mineralogy was extensive and accurate and at his ready command. Farmers and horticulturists came to him and learned how to check the ravages of destructive insects; physicians sent rare or new human parasites and were told their nature and habits and the best means of prevention; jewelers brought rare gems and learned their value. His comments, at the Academy, on the recent additions to its collections gave a most impressive illustration of his ready command of his vast store of knowledge of natural history.

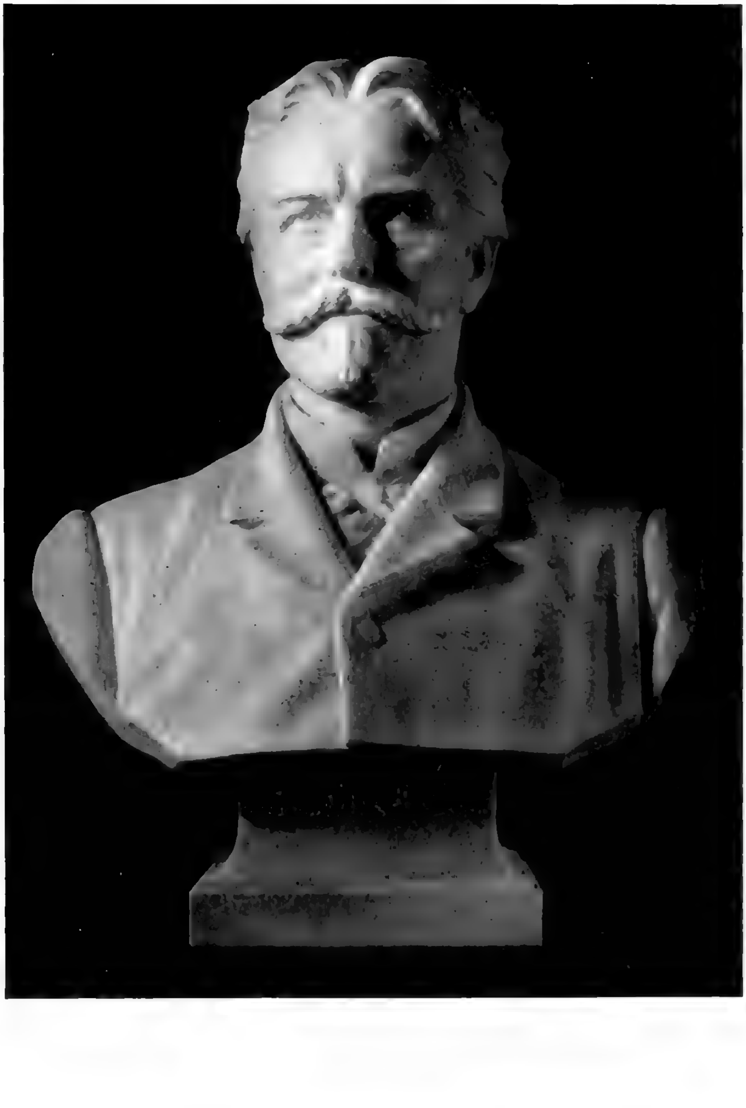
Leidy wrote no books, in the popular meaning of the word. He undertook the solution of no fundamental problem of biology. There are few among his six hundred publications that would attract unscientific readers, or afford a paragraph for a newspaper. They are simple and lucid and to the point. Most of them are short, although he wrote several more exhaustive monographs. They cover a wide field, but most of them fall into a few groups. Many deal with the parasites of mammals — among them, one in which his discovery of trichena in pork is recorded.

Two hundred and sixteen, or about one third, of his publications are

on the extinct vertebrates of North America. His first paper on palæontology was published in 1846, and his last in 1888, as the subject occupied him for more than forty years. He laid, with the hand of a master, the foundation for the palæontology of the reptiles and mammals of North America, and we know what a wonderful and instructive and world-renowned superstructure his successors have reared upon his foundation. It was this work that established his fame and brought his honors and rewards. They who hold it to be his best title to be enrolled among the pioneers of science in America are in the right, in so far as the founder of a great department of knowledge is most deserving of commemoration; but I do not believe it was his most characteristic work.

I can mention but one of the results of his study of American fossils. He showed, in 1846, that this continent was the ancestral home of the horse, and he sketched, soon after, the outline of the story of its evolution which later workers have made so familiar.

More than half his papers are on a subject which seems to me to contain the lesson of his life. Like Gilbert White, he was a home naturalist, devoted to the study of the natural objects that he found within walking distance of his home, but he penetrated far deeper into the secrets of the living world about him than White did, finding new wonders in the simplest living being. In the intestine of the cock-roach, and in that of the white ant, he found wonderful forests of microscopic plants that were new to science, inhabited by minute animals of many new and strange forms. His beautifully illustrated memoir on *A Flora and Fauna Within Living Animals* is one of the most remarkable works in the whole field of biological literature. Another memoir gives the results of his study of the anatomy of snails and slugs. The inhabitants of the streams and ponds in the vicinity of his home furnished an unfailing supply of material for research and discovery, and many of his publications are on aquatic animals. He finally became so much interested in the fresh-water rhizopods that he abandoned all other scientific work in order to devote his attention exclusively to these animals. His results were published in the memoir on *The Fresh-water Rhizopods of North America.* This is the most widely known of his works. It is, and must long be, the standard and the classic upon its subject. I have no time to dwell upon his work as the naturalist of the home — his best and most characteristic work. Its lesson to



EDWARD DRINKER COPE

Born, Philadelphia, July 28, 1840
Died, Philadelphia, April 12, 1897

Palæontologist, biologist, philosopher

Noted for his discoveries among the vertebrate fossils of western United States and his deductions from their study

later generations of naturalists seems to me to be that one may be useful to his fellow-men and enjoy the keen pleasure of discovery and come to honor and distinction, without visiting strange countries in search of rarities, without biological stations and marine laboratories, without the latest technical methods, without grants of money, and, above all, without undertaking to solve the riddles of the universe or resolving biology into physics and chemistry.

If one have the simple responsive mind of a child or of Leidy, he may, like Leidy, "find tongues in trees, books in the running brooks, sermons in stones and good in everything."

EDWARD DRINKER COPE.

By Henry Fairfield Osborn.

In the marble portrait of Edward Drinker Cope, you see the man of large brain, of keen eye and of strong resolve, the ideal combination for a life of science, the man who scorns obstacles, who while battling with the present looks above and beyond. The portrait stands in its niche as a tribute to a great leader and founder of American palæontology, as an inspiration to young Americans. In unison with the other portraits its forcible words are: "Go thou and do likewise."

Cope, a Philadelphian, born July 28, 1840, passed away at the early age of fifty-seven. Favored by heredity, through distinguished ancestry of Pennsylvania Quakers, who bequeathed intellectual keenness and a constructive spirit. As a boy of eight entering a life of travel and observation, and with rare precocity giving promise of the finest qualities of his manhood. Of incessant activity of mind and body, tireless as an explorer, early discovering for himself that the greatest pleasure and stimulus of life is to penetrate the unknown in Nature. In personal character fearless, independent, venturesome, militant, far less of a Quaker in disposition than his Teutonic fellow citizen Leidy. Of enormous productiveness, as an editor conducting the *American Naturalist* for nineteen years, as a writer leaving a shelf-full of twenty octavo and three great quarto volumes of original research. A man of fortitude, bearing material reverses with good cheer, because he lived in the

world of ideas and to the very last moment of his life drew constant refreshment from the mysterious regions of the unexplored.

In every one of the five great lines of research into which he ventured, he reached the mountain peaks where exploration and discovery guided by imagination and happy inspiration gave his work a leadership. His studies among fishes alone would give him a chief rank among zoölogists, on amphibians and reptiles there never has been a naturalist who has published so many papers, while from 1868 until 1897, the year of his death, he was a tireless student and explorer of the mammals. Among animals of all these classes his generalizations marked new epochs. While far from infallible, his ideas acted as fertilizers on the minds of other men. As a palæontologist, enjoying with Leidy and Marsh that Arcadian period when all the wonders of our great West were new, from his elevation of knowledge which enabled him to survey the whole field with keen eye he swooped down like an eagle upon the most important point.

In breadth, depth and range we see in Cope the very antithesis of the modern specialist, the last exponent of the race of the Buffon, Cuvier, Owen and Huxley type. Of ability, memory and courage sufficient to grasp the whole field of natural history, as comparative anatomist he ranks with Cuvier and Owen; as palæontologist with Owen, Marsh and Leidy — the other two founders of American palæontology; as natural philosopher less logical but more constructive than Huxley. America will produce men of as great, perhaps greater genius, but Cope represents a type which is now extinct and never will be seen again.

Guide Leaflet No. 25

American Museum of Natural History

AMERICAN MUSEUM OF NATURAL HISTORY

The Foyer Collection of Meteorites

By EDMUND OTIS HOVEY, Ph. D.

Associate Curator of Geology

GUIDE LEAFLET NO. 26

DECEMBER, 1907

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members..........	\$ 10	Fellows........................	\$ 500
Life Members.............	100	Patrons........................	1000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year.

WESTERN HALF OF FOYER.

Showing the following Meteorites: Ahnighito, Brenham, Forest City, The Dog, The Woman.

THE METEORITES

IN THE FOYER OF THE

American Museum

OF

NATURAL HISTORY

By EDMUND OTIS HOVEY, Ph. D.

ASSOCIATE CURATOR OF GEOLOGY

NO. 26

OF THE

GUIDE LEAFLET SERIES

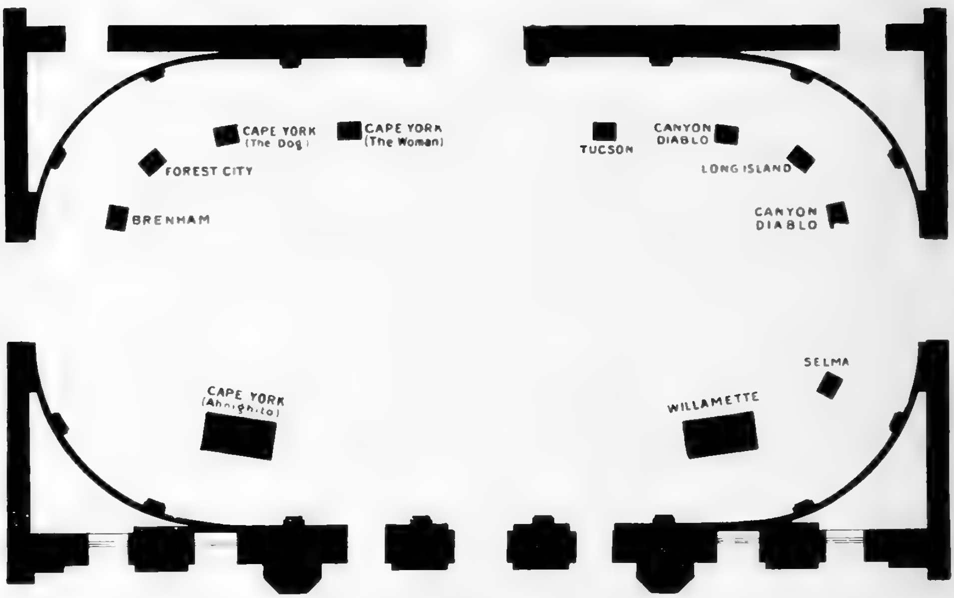
OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. December, 1907

NORTH



THE FOYER. NO. 104.

First (Ground) Floor, Central Section of Building.

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS.

THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY.[1]

By Edmund Otis Hovey, Ph. D.

Associate Curator of Geology.

Introduction.

SCARCELY a century ago the scientific and even the popular world scoffed at the idea that masses of matter could possibly come from outer space (or "heaven") and strike the surface of the earth,— in other words that stones could fall from the sky. Even at the present time, although it is well known that occasionally masses of metal and stone — "meteorites" — do fall from the sky, there is much misinformation current in regard to their character and the conditions under which they have come to the earth.

Livy, Plutarch and other early historians mention several stones which had been seen to fall from the sky. Among these were a stone which fell in Phrygia and was kept there for centuries until it was removed to Rome about 204 B. C. with imposing ceremonies; a shower of stones that fell in the Alban Mountains near Rome about 652 B. C., and a stone that fell in Thrace in the fifth century B. C. and was known to Pliny five hundred years later. The image of the goddess Diana which was preserved at Ephesus is said to have "fallen down from Jupiter" and was probably a meteorite, and idol known as the Venus of Cyprus seems likewise to have had the same origin. Stones which have fallen from the sky have been regarded as being of miraculous origin and have been worshiped by many primitive peoples. They have been viewed with awe too by tribes and nations which could not be considered primitive, including some in India, China and Japan.

Arguments which form strange reading at the present day were advanced by eminent scientists against the idea that any bodies could come to the earth from space, and French scientists were particularly

[1] *Guide Leaflet No. 26* of the American Museum series.

vehement in their denial of such origin. Even the famous chemist Lavoisier was one of a committee of three who presented to the French Academy in 1772 a report upon a stone, the fall of which was said to have occurred at Lucé four years previously. They recorded their opinion that the stone was an ordinary one which had been struck by lightning. It was, nevertheless, a true meteorite.

Early in the year 1794 Professor Chladni, a renowned German physicist, published a thesis in which he collated many accounts of bodies which had been said to have fallen from the sky, discussed the nature of the bodies themselves and expressed the conviction that bodies could and did come to our earth from space. Chladni devoted particular attention to the iron-and-stone mass known as the "Medwedewa" meteorite and the iron mass known as Campo del Cielo. The former of these was first described by the traveler Pallas, who saw it in the year 1772 at the city of Krasnojarsk, Siberia. The latter was found by Indians in the interior of Argentina, South America, and was first visited in the year 1783 by Don Michael Rubin de Celis, who calculated the weight of the mass to be 30,000 pounds.

As if in direct confirmation of Chladni's theory, a shower of stones fell at Siena, Italy, on June 16, 1794, and the occurrence is thus described in connection with the account of an eruption of Vesuvius by Sir William Hamilton[1]:

"I must here mention a very extraordinary circumstance indeed, that happened near Sienna in the Tuscan state, about 18 hours after the commencement of the late eruption at Vesuvius on the 15th of June, though that phenomenon may have no relation to the eruption; and which was communicated to me in the following words by the Earl of Bristol, bishop of Derry, in a letter dated from Sienna, July 12th, 1794: 'In the midst of a most violent thunder-storm, about a dozen stones of various weights and dimensions fell at the feet of different people, men, women, and children; the stones are of a quality not found in any part of the Siennese territory; they fell about 18 hours after the enormous eruption of Vesuvius, which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon: either these stones have been generated in this igneous mass of clouds, which produced such unusual thunder, or, which is equally incredible, they were thrown from Vesuvius at a distance of at least 250

[1] Philosophical Transactions of the Royal Society of London. Abr. ed., 1809, vol. XVII, p. 503.

miles; judge then of its parabola. The philosophers here incline to the first solution. I wish much, Sir, to know your sentiments. My first objection was to the fact itself; but of this there are so many eye-witnesses, it seems impossible to withstand their evidence, and now I am reduced to a perfect scepticism.' His lordship was pleased to send me a piece of one of the largest stones, which when entire weighed upwards of 5 lb.; I have seen another that has been sent to Naples entire, and weighs about 1 lb. The outside of every stone that has been found, and has been ascertained to have fallen from the cloud near Sienna, is evidently freshly vitrified, and is black, having every sign of having passed through an extreme heat; when broken, the inside is of a light grey color mixed with black spots, and some shining particles, which the learned here have decided to be pyrites, and therefore it cannot be a lava, or they would have been decomposed."

Scientists, however, are often hard to convince, and some of that day contended that the Siena stone had been formed in the air by condensation of the particles of dust in an eruption cloud from Vesuvius, in spite of the fact that Siena is 250 miles distant from the volcano and that the largest stone of the shower weighed 7½ pounds, while several weighed more than 1 pound each. Even the 56-pound stone which fell December 13, 1795, at Wold Cottage near Scarborough, Yorkshire, England, almost at the feet of a laborer, did not dislodge this theory from the mind of Edward King, its originator.

The cloud theory was completely disproved at Krakhut near Benares, India, on December 19, 1798, when, directly after the passage of a ball of fire through the air, a heavy explosion or a series of explosions was heard and many stones[1] fell from a sky which had been perfectly cloudless for a week before the event and remained so for many days afterward. Even these facts, however, did not fully convince the scientists of France and it required the occurrence of the meteoritic shower of L'Aigle, France, April 26, 1803, for final proof.[2] L'Aigle is easily accessible from Paris and M. Biot, a noted physicist was sent at once to investigate the matter. Biot learned that on the day mentioned a violent explosion occurred in a practically clear sky in the vicinity of

[1] Represented in the general meteorite collection, Morgan Hall, No. 404 of the fourth floor of this building, by a small fragment one fourth of an ounce (8 grammes) in weight.

[2] A fragment of L'Aigle weighing 5 ounces (157 grammes) is in the general collection.

L'Aigle which was heard over an area seventy five miles in diameter directly after a swiftly moving fire-ball had been seen to pass through the air. The explosion, or series of explosions, was immediately followed by the fall of two or three thousand stones within an elliptical area about $6\frac{1}{4}$ miles long and $2\frac{1}{2}$ miles wide. The largest of the stones weighed 20 pounds, the next largest $3\frac{1}{2}$ pounds, but most of the fragments were very small. The occurrence at L'Aigle proved the correctness of another of Chladni's theories, which was that "fire balls" in the sky were nothing more or less than meteorites in flight.

The oldest still existing meteorite of the fall of which we have an exact record is that of Ensisheim, in Elsass, Germany.[1] An ancient document states:

"On the sixteenth of November, 1492, a singular miracle happened: for between 11 and 12 in the forenoon, with a loud crash of thunder and a prolonged noise heard afar off, there fell in the town of Ensisheim a stone weighing 260 pounds. It was seen by a child to strike the ground in a field near the canton called Gisguad, where it made a hole more than five feet deep. It was taken to the church as being a miraculous object. The noise was heard so distinctly at Lucerne, Villing, and many other places, that in each of them it was thought that some houses had fallen. King Maximilian, who was then at Ensisheim, had the stone carried to the castle; after breaking off two pieces, one for the Duke Sigismund of Austria and the other for himself, he forbade further damage, and ordered that the stone be suspended in the parish church."[2]

Within the past century many stones and some masses of iron have been seen to fall from the sky and afterwards have been collected and are now in cabinets, while several hundred specimens have been found which are so much like the positively known meteorites that they have been classed with them and are jealously guarded in collections.

Classification.

Meteorites are generally divided into three classes according to their mineral composition:

1. "Siderites," or iron meteorites, which consist essentially of an alloy of iron and nickel;

[1] A fragment of this meteorite weighing about four ounces (129 grammes) is in the general meteorite collection.

[2] Fletcher. An Introduction to the study of Meteorites. P. 19. 1888.

AHNIGHITO, THE GREAT CAPE YORK METEORITE

Weight, more than 36.5 tons. The largest and heaviest meteorite known.

2. "Siderolites," or iron-stone meteorites, which are formed of a nickel-iron sponge, or mesh, containing stony matter in the interstices;
3. "Aërolites," or stone meteorites, which are made up mainly of stony matter, but almost always contain grains of nickel-iron scattered through their mass.

The line of demarcation between these classes is not always sharp, and there are many subordinate kinds of aërolites.

Countless numbers of meteoritic bodies, mostly of minute size, must exist within the boundaries of the solar system, since from fifteen to twenty millions of them enter the earth's atmosphere every day. Almost all of these are dissipated in our atmosphere through heat produced by friction with the air, so that the only evidence of their presence is a trail of light across the sky. This usually is visible only at night, and is familiar to all as a shooting star or meteor. Shooting stars are to be seen almost every evening, but they are particularly abundant during August and November. Sometimes the November shower of meteors has been so pronounced that the sky has seemed fairly to radiate lines of fire, an effect far surpassing in brilliance the most ambitious artificial fire works. Not one in a hundred million of these shooting stars, however, reaches the earth in a recognizable mass; in fact, there are records of only about 685 known meteorites which are represented in museums and private cabinets.

The weight of known meteorites varies between wide limits. The lightest independent mass is a stone meteorite weighing about one sixth of an ounce called Mühlau from the town in the vicinity of Innsbruck, Austria, near which it was found in 1877; the heaviest mass known is Ahnighito, of the Foyer collection, an iron meteorite weighing more than thirty-six and one half tons which came from Cape York, Greenland. Some showers of meteorites have furnished even smaller individuals than Mühlau. Forest City, well represented in the Foyer collection, has been found in fragments weighing one twentieth of an ounce. Pultusk is a famous fall and the smallest of the "Pultusk peas," as the material is called, weigh less than one thirtieth of an ounce each, while Hessle fell in a veritable rain of meteoritic dust, the smallest particles of which weigh about one four hundred twenty-fifth of an ounce and could never have been found had they not fallen on an ice-covered lake, where they were readily seen and recognized.

Meteoritic masses are almost certainly extremely cold during their existence in outer space, but when they come into the earth's atmosphere friction with the air raises the temperature of the surface to the melting point, producing a great amount of dazzling light as well as superficial heat. In spite of this surface fusion, it is highly probable that the duration of the aërial flight of a meteorite is so short that in many cases the interior does not become even warm.[1]

The rapid heating of the exterior and the differences of temperature between different parts of a meteorite often lead to its rupture before it reaches the ground. This is particularly the case with stone meteorites, the iron meteorites being tough enough usually to withstand the fracturing agencies. Most of the meteorites which have burst have furnished only two or three fragments, so far as known, but a few have furnished many, while there have been found 700 pieces of Hessle, 1000 pieces of Forest City, several thousand each of Knyahinya and L'Aigle, and about one hundred thousand each of Mocs and Pultusk. The name "stone shower" has been appropriately given to the falls comprising many individuals. "Iron showers" from bursting siderites are much rarer than the stone showers, only six are known to have occurred, among which Canyon Diablo leads, several thousands of fragments of this famous fall having been found.

The breaking up of a meteorite is accompanied by an explosion or series of explosions, and often these are startling in their sharpness and intensity, when they occur near the earth. Forest City, 268 pounds of which have been found, just before falling burst in a series of explosions which were heard over an area two hundred miles in diameter. There were three distinct detonations connected with the fall near Butsura, Bengal, which were heard at Goruckpur sixty miles away, although the meteorite was a small one, less than fifty pounds of it having been found. The occurrences at Krakhut, L'Aigle and Ensisheim have already been mentioned.

Chemical Composition.

Some forty one elements, four of which are gases, are said to occur in meteorites, but several of these may be regarded as doubtful. The

[1] See also page 18.

most abundant have been arranged by Dr. O. C. Farrington[1] in the following order of importance:

1. Iron	3. Silicon	5. Nickle	7. Calcium
2. Oxygen	4. Magnesium	6. Sulphur	8. Aluminum

The other elements of particular importance in this connection are carbon, chlorine, chromium, cobalt, copper, hydrogen, manganese, nitrogen, phosphorus, potassium and sodium.

Mineral Constituents.

Seven elements have been found in meteorites in the elemental or uncombined state. They are iron, nickel, cobalt and copper in the form of alloys, carbon, hydrogen and nitrogen. With these exceptions, the constituents of meteorites are chemical compounds and all but six of the whole list have their exact equivalents in minerals which are found in the crust of the earth.

According to most authorities the constituents of meteorites may be divided into essential and accessory components as follows[2]:

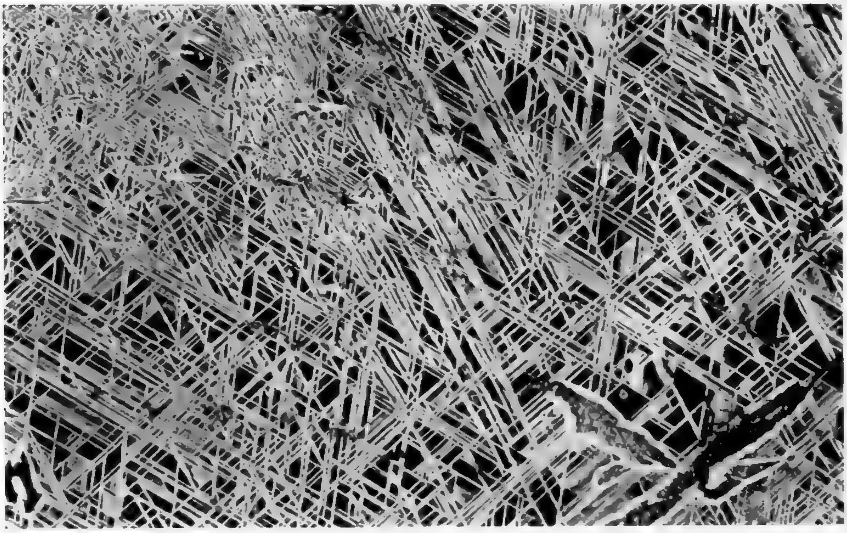
Essential.	*Accessory.*
Nickel-iron	*Schreibersite
Olivine (chrysolite)	Diamond
Pyroxenes (Orthorhombic)	Graphite (Cliftonite)
Pyroxenes (Monoclinic)	Hydro-carbons.
Feldspar (Plagioclase)	Cohenite
*Maskelynite.	*Moissanite
	*Troilite
	Pyrrhotite
	*Daubréelite
	*Oldhamite
	Tridymite
	Chromite
	Magnetite
	Osbornite
	Lawrencite
	Glass

[1] Journal of Geology. Vol. IX, p. 394. 1901.

[2] E. Cohen. Meteoritenkunde I, p. 322. 1894. The asterisk indicates the minerals which are peculiar to meteorites and are not known to occur in the earth's crust.

Essential Constituents.

The iron of meteorites is always alloyed with from 6 to 20 per cent of nickel. This "nickel-iron," as it is commonly called, is usually crystalline in texture, and when it is cut, polished and "etched" a beautiful network of lines is brought out, indicating plates which lie in positions determined by the crystalline character of the mass. This network of lines constitutes what are called the Widmanstätten figures, from the name of their discoverer. When these figures are strongly developed, the meteoritic origin of the iron cannot be questioned, but their absence does not necessarily disprove such an origin. Native iron of terrestrial

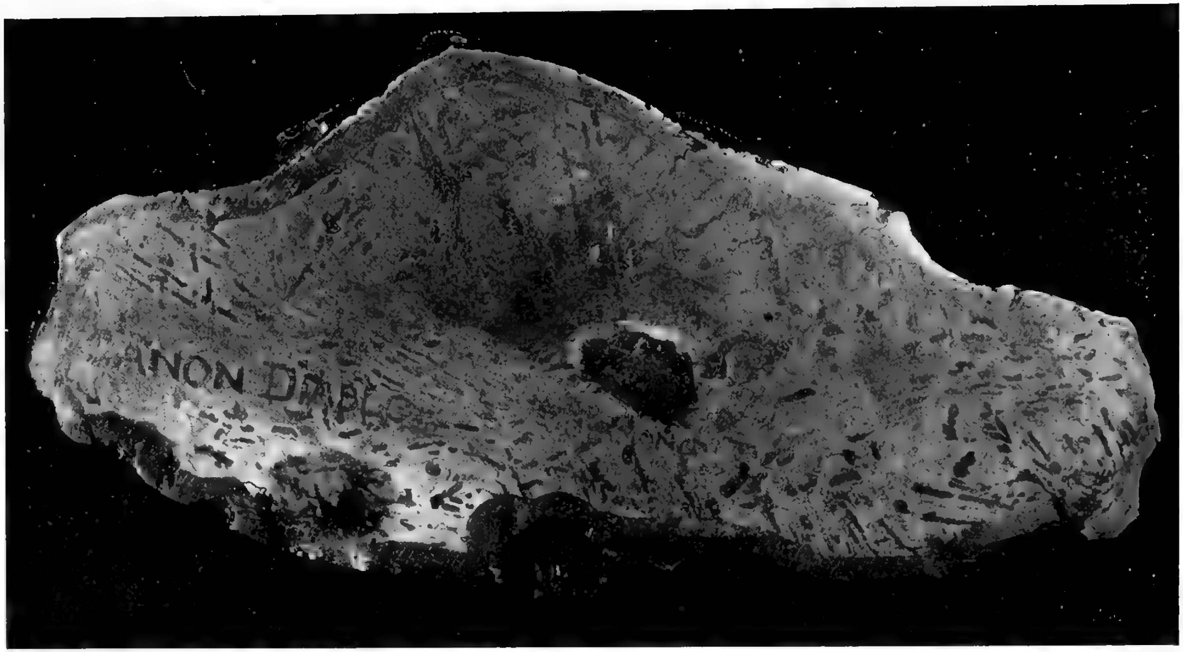


WIDMANSTÄTTEN LINES, OR FIGURES.

Carleton Iron Meteorite. Natural size. In this iron the plates are very thin.

origin is extremely rare and has been found almost exclusively at Disco Island and immediate vicinity on the west coast of Greenland. The Disco, or Ovifak, iron contains less nickel than meteoritic iron, while other terrestrial nickel-irons (*i. e.* awaruite and josephinite) contain much more. Small quantities of metallic cobalt are also alloyed with the nickel and a little copper is sometimes found in the same association.

Next to nickel-iron the mineral olivine, or chrysolite, is the most important constituent. This is a silicate of magnesium, always con-



15

CANYON DIABLO. ETCHED SECTION SHOWING WIDMANSTÄTTEN LINES

A diamond was found in the black spot in this section.

taining some iron, which occurs in all the siderolites and most of the aërolites, sometimes comprising a considerable portion of their mass. It is a dark yellowish-green to black, glassy mineral usually occurring as rounded or angular grains, but sometimes as crystals. It is prominent in a slice of Brenham in the Foyer collection, where it forms glassy grains in a mesh of nickel-iron. Olivine is the gem, peridot.

The minerals belonging to the group known as orthorhombic pyroxenes are next to olivine in point of abundance. Chemical analyses show that all gradations are present from the colorless enstatite to the almost black hypersthene members of the group. The monoclinic pyroxenes, which are important constituents of terrestrial igneous rocks, are represented in meteorites by only two forms, an iron-alumina pyroxene like common augite and one nearly free from iron and without alumina which is to be compared with diopside. The augite-like mineral is brown to green in color and occurs usually in grains or splinters rarely in crystals. It has been found in many meteorites, but diopside has been identified only once with certainty.

The great feldspar series has been identified in meteorites in four of its forms, namely: anorthite, albite, oligoclase and labradorite. Of these, anorthite has been found forming a large part (35 per cent.) of some meteorites and measurable crystals have been obtained, but in most cases where feldspar occurs in a meteorite, it has been possible to go no farther than to identify it as belonging to the plagioclase section of the mineral group.

Maskelynite is a transparent, colorless, glassy mineral. In chemical composition it is related to the terrestrial species leucite, but it is a distinct form and thus far is known only from meteorites. It is not known to occur in any of the meteorites displayed in the Foyer.

Accessory Constituents.

Schreibersite is a phosphide of iron, nickel and cobalt which is probably peculiar to meteorites. It is tin-white in color, changing to bronze-yellow or steel gray on exposure to the air. In structure it is granular, flaky, crystalline or needle-like. Next to nickel-iron schreibersite is the most generally disseminated constituent of siderites and forms some of the shining lines to be seen on etched sections.

Carbon occurs in at least three forms in meteorites, as the diamond,

as graphite (cliftonite) and as hydrocarbons. Diamonds were first found in Canyon Diablo in 1891. They are extremely minute in size but recognizable crystals have been obtained. Graphite (cliftonite) occurs usually in nodules and only in siderites in particles that are large enough for easy examination. The material is very fine. The cliftonite form of graphite is considered by most authorities to be a pseudomorph after diamond.

Hydrocarbons of several kinds have been found in meteorites. According to Cohen[1] they may be grouped into three classes: (1) compounds of carbon and hydrogen alone; (2) compounds of carbon, hydrogen and oxygen; (3) compounds of carbon, hydrogen and sulphur. None of the meteorites in the Foyer collection is known to contain any hydrocarbon, but the fact that any meteorite should contain such substances is of great scientific interest. It is pretty clear that they belong to the pre-terrestrial history of the masses; hence, since they are readily combustible or volatile, the meteorites that contain them cannot have been heated to high temperatures, at any rate, subsequent to the formation of the compounds. This is an additional argument in support of the statement already made that the heating of meteorites during aërial flight is, in many instances at least, only superficial. Furthermore, the existence of hydrocarbon compounds in meteorites, where no life can have existed, shows that organisms are not absolutely necessary to the formation of such compounds in the earth's crust.

Cohenite, which is a carbide of iron, nickel and cobalt, is tin-white in color and looks like schreibersite. It is much rarer, however, and occurs in isolated crystals. The only terrestrial occurrence of cohenite is in the basaltic iron of Greenland. Moissanite, the natural carbide of aluminum corresponding to the artificial carborundum, has thus far been found only in Canyon Diablo, where it occurs in microscopic crystals. It is the latest discovery among the constituents of meteorites, having been found in 1905 by Henri Moissan.

As far as investigations have been carried, heating develops the fact that meteorites contain gases condensed within them, either by occlusion in the same way that platinum and zinc absorb hydrogen or by some form of chemical union. According to Cohen[2] the following gases have

[1] Meteoritenkunde. Heft I, p. 159.

[2] Meteoritenkunde. Heft I, p. 169

been found: hydrogen, carbon dioxide, carbon monoxide, nitrogen and marsh gas (light carburetted hydrogen).

Troilite is common in meteorites and constitutes brass- or bronze-yellow nodules, plates and rods which are to be seen in nearly every section, particularly of siderites. The mineral is usually considered to be the simple sulphide of iron, FeS, but its exact chemical composition and crystalline structure are still matters of investigation and dispute. Canyon Diablo and Willamette contain, or contained, much troilite in the shape of rods, and the fusion and dissipation of this mineral during the aërial flight of the masses gave rise to some of the holes which penetrate them, and the same statement is true of many other meteorites. Pyrrhotite, the magnetic sulphide of iron, $Fe_{11}\ S_{12}$, occurs in stone meteorites and chiefly in the form of grains. Daubréelite is likewise a sulphide of iron, but it differs from those just mentioned through containing much chromium, giving the chemical formula FeS, $Cr_2\ S_3$. The mineral is peculiar to siderites and siderolites and has never been found in the stone meteorites or in the earth's crust. It occurs in Canyon Diablo, where it may be seen surrounding nodules of troilite as a black shell with metallic luster.

Oldhamite, a sulphide of calcium, CaS; tridymite, a form of silica, SiO_2; chromite, an oxide of iron and chromium, $FeCr_2\ O_4$; magnetite, the magnetic oxide of iron, $Fe_3\ O_4$; osbornite, another sulphide or oxysulphide of calcium, and lawrencite a chloride of iron, $Fe\ Cl_2$, occur sparingly in some meteorites. Lawrencite manifests itself rather disagreeably through alteration to the ferric chloride, which oozes out of the masses of iron and stands in acrid yellow drops on the surface or runs in streaks to the bottom. Glass like the volcanic glass of terrestrial rocks seems never to be absent from the interior of stone meteorites, but from the nature of the case it is not found in iron meteorites.

Surface Characteristics.

The surface of a newly-fallen meteorite always consists of a thin veneer or crust which differs in marked degree from the interior of the mass. In the case of the siderites, this seems to be a polish due to melting and friction, together with partial oxidation. Some iron meteorites which are known to have lain long in the ground likewise show a crust which is somewhat similar in appearance, but it is due to slow oxidation

or "rusting" in the ground and is called the rust crust. Almost without exception the aërolites are covered with a crust, the appearance of which varies according to the mineral composition of the mass. The crust is almost always black and is usually dull, but sometimes it has high luster. A few meteorites possess a dark-gray crust, and some show crust only in patches.

The crust of the stone meteorites is glassy in character on account of its being composed of silicates which have been cooled rapidly from fusion. This glass, like glasses of volcanic origin, does not long resist the atmospheric agents of decay, hence it is usually missing from those aërolites which have lain long in the earth or it is much decomposed, as may be seen by examining Long Island and Selma in the Foyer collection. The crust varies in thickness on different parts of a meteorite and often shows ridges and furrows which are due to friction with the air. Frequently the ridges or furrows radiate from one or more centers in such manner as to show which side of the mass was forward during its flight through the air. So quickly is the crust formed that even the smallest members of a meteorite shower usually possess a complete crust. In the case of angular fragments the crust on the different sides can usually be distinguished as "primary" or "secondary" according to whether it was a part of the original exterior of the mass or was formed upon the new surfaces exposed by the bursting of the meteorite.

Another common surface characteristic of meteorites is an abundance of shallow depressions or pittings, which on account of their form have been called "thumb marks," or piëzoglyphs. These pittings are so shallow and superficial in character that exposure to the atmosphere obscures or obliterates them in a comparatively short time. The rusting of an iron meteorite may produce similar shallow depressions, as will be seen from an examination of the surfaces of the great hollows in Willamette. The true piëzoglyphs doubtless owe their origin to several different causes, the most potent of which are unequal softening of a mass due to varying chemical composition and rapidly changing pressure and consequent erosion during flight through the atmosphere.

Without going more deeply into the subject in general we may now turn our attention to the Foyer collection.

CAPE YORK.
"The Woman". Weighs 3 tons.

THE CAPE YORK METEORITES,

"AHNIGHITO," OR "THE TENT," "THE WOMAN" AND "THE DOG."

(Siderites.)

For centuries, and perhaps for thousands of years, the three masses of iron known as the Cape York meteorites lay on the north coast of Melville Bay near Cape York, Greenland, but they were seen for the first time by a white person, when they were visited by Commander Robert E. Peary, U. S. N., in 1894 and 1895 under the guidance of Tallakoteah, a member of the Eskimo tribe which up to the early part

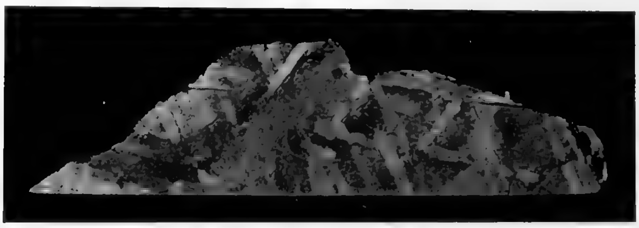
CAPE YORK.
"The Dog". Weighs 1100 pounds.

of the nineteenth century had obtained material for knives and other utensils from the masses.

The three meteorites were known as a group to the Eskimo under the

name of "Saviksue" or "The Great Irons," and each had its own name suggested by its shape. The smallest mass, weighing about 1,100 pounds, was called "The Dog"; the next larger mass, weighing about three tons, was named "The Woman," because the shape was thought to suggest the squatting figure of a woman with a babe in her arms and a shawl thrown about her, and the largest mass, weighing more than thirty six and one half tons, was known as "The Tent." The last, however, has been formally christened by the daughter of the explorer with her own name, "Ahnighito." This great mass is 10 feet 11 inches long, 6 feet 9 inches high and 5 feet 2 inches thick.

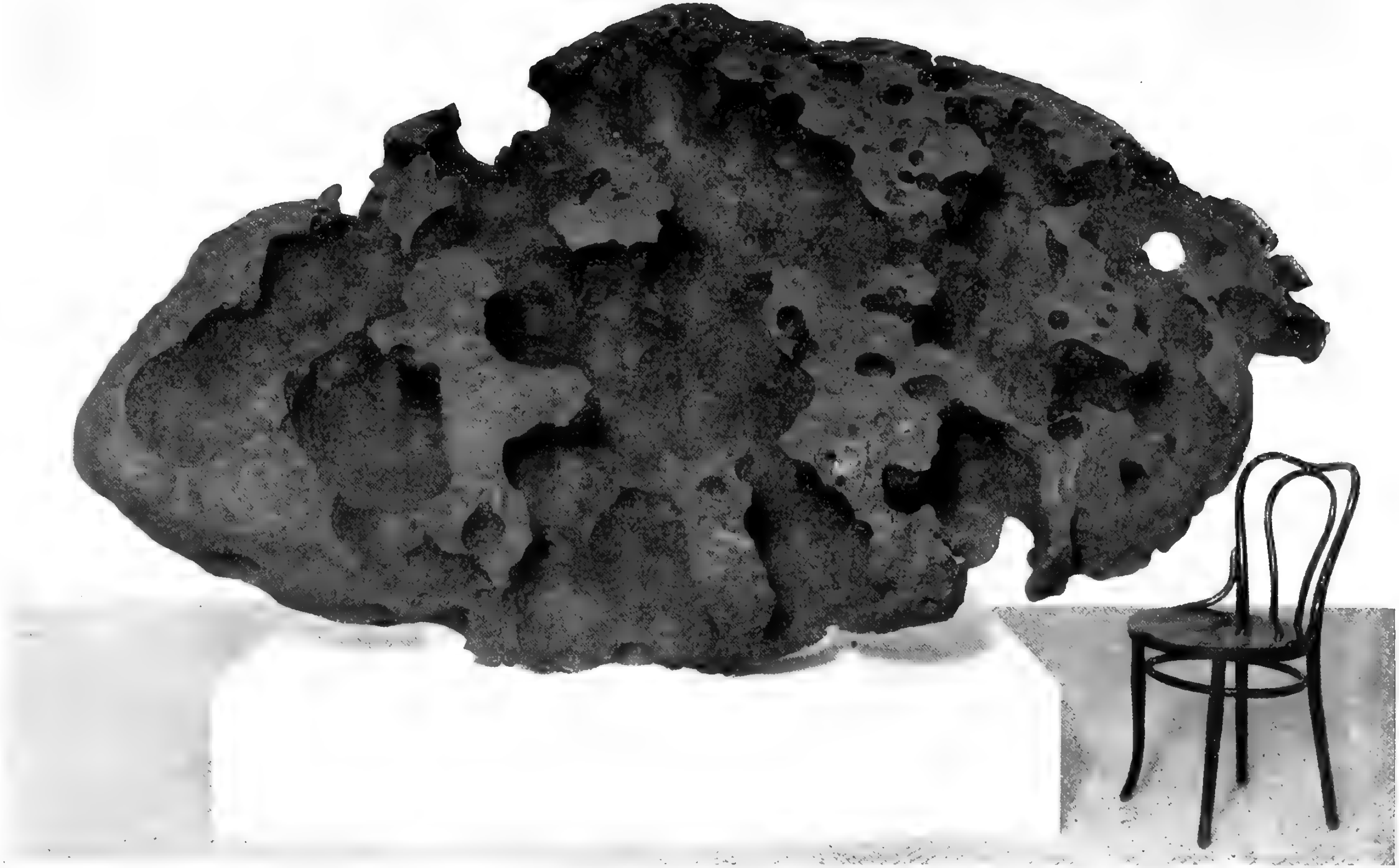
The Woman and the Dog were visited by Peary in 1894 and were obtained the following year after much difficult and exciting work, an incident of which was the breaking up of the cake of ice on which the Woman had been ferried from the shore to ship just as the mass was about to be hoisted aboard. Fortunately there was enough tackle around the meteorite to prevent its loss. In 1895, Commander Peary visited Ahnighito, also, which lay on an island only four miles from the two smaller masses, but he could do little toward its removal. The next year he made another voyage for the purpose of getting the great iron but was unsuccessful. His third attempt was made in 1897, and the meteorite was brought safely to New York in the ship "Hope."



SECTION OF AHNIGHITO. NATURAL SIZE.
Shows broad Widmanstätten lines.

The three masses are closely similar in chemical composition, analyses by J. E. Whitfield giving the following results:

	The Dog.	The Woman.	Ahnighito.
Iron	90.99%	91.47%	91.48%
Nickel	8.27%	7.78%	7.79%
Cobalt	0.53%	0.53%	0.53%



25

WILLAMETTE. (GIFT OF MRS WILLIAM E. DODGE.)

Length 10 feet, height 6 feet 6 inches. Weight 15.6 tons. Rear side, showing deep pits formed by oxidation.

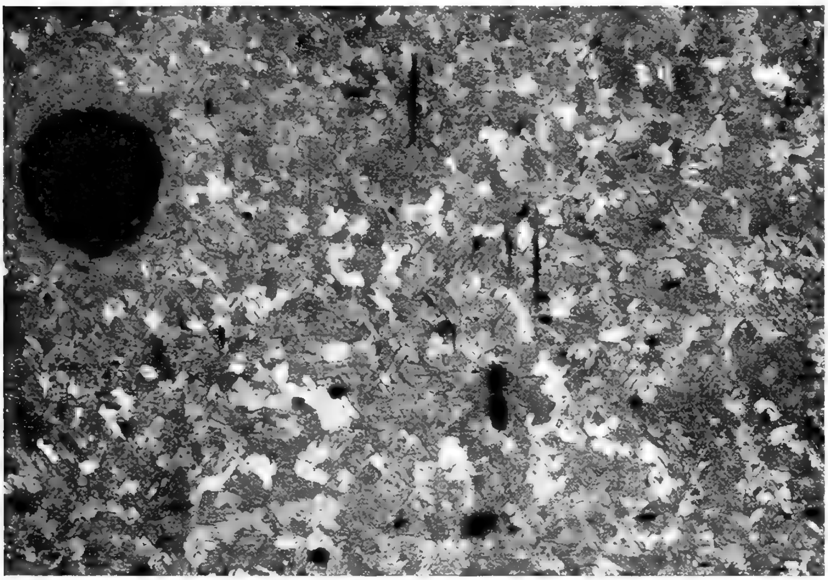
Besides these metals there are present small quantities of copper, sulphur, phosphorus and carbon. The similarity in chemical composition and the close proximity in which the masses lay when found indicate the probability that they are parts of the same fall.

WILLAMETTE

(*Siderite.*)

GIFT OF MRS. WILLIAM E. DODGE.

This is the most interesting iron meteorite, as to external characteristics, which has ever been discovered, and it is the largest ever found in the United States. Its chief dimensions are, length 10 ft., height



SECTION OF WILLAMETTE.

6 ft. 6 in., thickness, 4 ft. 3 in. On the railroad scales in Portland, Oregon, the net weight was shown to be 31,107 lbs.

Willamette was discovered in the autumn of 1902 in the forest about nineteen miles south of Portland, by two prospectors who were searching for ledges likely to contain mineral wealth, particularly gold or silver.

The finders at first supposed that they had come upon a ledge of solid iron, but the meteoritic character of the mass was soon ascertained. Later one of the prospectors removed the meteorite to his own ranch three-quarters of a mile distant, but the owners of the land on which it had been found instituted suit for its recovery, and the contest was carried to the supreme court of the State before the finder relinquished his claim. The specimen was received at the Museum in April, 1906.

The most striking characteristic of Willamette, next to its size, is the series of hollows and deep pits which indent its surface. The broad shallow hollows on the front side, "brustseite," (side now turned toward the wall) were probably caused by friction against the atmosphere and consequent melting and flowage of the iron during the flight of the meteorite through the air. The deep pot-like pits on the rear side (the side now facing the center of the Foyer) are most probably due to rusting while the meteorite was lying in the ground where it fell, and they seem to have had their origin in the decomposition of spheroidal nodules of troilite. Note also the cylindrical holes which penetrate deeply into the mass from both sides. These probably began with the decomposition of rod-like masses of troilite. In addition to these holes and pits the surface of the mass is indented with small shallow depressions which also seem to be a feature of the decomposition of the iron.

A fractured face shows Willamette to be remarkable for its coarse granular texture, the grains being bounded by almost definite planes suggesting crystals. A polished and etched surface shows rather broad Widmanstätten lines. Chemical analysis shows that the meteorite contains about 91.55 per cent iron, 8.09 per cent nickel and a small amount of cobalt, phosphorus and sulphur.

CANYON DIABLO.

(Siderite.)

Canyon Diablo is a siderite which is popularly famous chiefly from the fact that it contains diamonds. This gem stone has been definitely proven to occur in only two meteorites, the other being a Russian fall, although many masses are known to contain carbon in the form of a soft

black powder. The discovery of diamonds in Canyon Diablo was made in 1891 by Professor G. A. Kœnig of Philadelphia and was afterward confirmed by Dr. George F. Kunz of New York, Professor Huntington of Harvard University, Professor Moissan of Paris and other investigators. In 1905 Moissan dissolved a fragment of Canyon Diablo weighing

CANYON DIABLO

Weight, 1087 pounds. Diamonds have been found in specimens of this fall.

several pounds and obtained not only recognizable crystals of the diamond, but also crystals of a mineral corresponding exactly in composition to the extremely hard artificial silicide of carbon (CSi_2) known as carborundum. This new mineral has been named moissanite, and this is the first time that it has been found in nature.

Canyon Diablo was found in 1891 at and near Coon Butte, Arizona, in the vicinity of the town of Canyon Diablo. The original size of the

mass is not known, but thousands of fragments have been collected, varying in weight from a fraction of an ounce up to 1,087 pounds. More than 16 tons of this material are said to have been found within the radius of 2½ miles of Coon Butte. Coon Butte is a conical hill rising from 130 to 160 feet above the surrounding plain and containing a crater-like hollow about three-quarters of a mile in greatest diameter and probably 1,460 feet deep originally.

There is no lava of any kind in Coon Butte or in its immediate vicinity, and it is now supposed to be most probable that the "crater" was caused by an immense meteorite striking the earth at this point. The main portion of the mass has not yet been discovered, the fragments which have thus far been found being only the portions separated from the original mass during its passage through the atmosphere and at the time of its impact with the earth.

Two fragments of Canyon Diablo are in the Foyer collection, one of which weighs 1,087 pounds and is the largest piece which has been discovered. It was described and figured by Professor Huntington in the Proceedings of the American Academy of Arts and Sciences, Boston, for 1894. A slice of the meteorite in which a diamond was found is in the general Museum collection and is figured on page 15.

A polished and etched section shows strong Widmannstätten lines which are comparatively broad and somewhat discontinuous. The meteorite consists of 91.26 per cent iron and 8.25 per cent nickel and cobalt, with small quantities of copper, platinum, iridium, phosphorus, sulphur, carbon and silicon. Nodules of troilite are abundant in some parts of the masses. Through decomposition and erosion these nodules have given rise to deep holes in the iron.

TUCSON.[1]

(Siderite.)

The Tucson meteorite, which is also known as the "Signet" or the

[1] This specimen is a reproduction in cast iron of the famous Tucson meteorite, the original of which is in the National Museum at Washington. The model from which this reproduction has been prepared was presented to the American Museum by the Smithsonian Institution. The original weighs 1,400 pounds, and this cast has the same weight.

"Ring" on account of its peculiar shape, was found in the Santa Catarina Mountains about thirty miles northwest of the city of Tucson, Arizona, and its existence was known to the Spaniards for at least two hundred years before the region became part of the United States. Tradition, indeed, relates that this and many other fragments fell in a single meteoritic shower about the middle of the seventeenth century. The attention of Americans was first drawn to this and its mate, the Carleton meteorite,

TUCSON, OR "SIGNET."
Weight, 1400 pounds. A cast in iron.

in 1851 by Professor John L. Leconte, who described them as being in use by the blacksmiths of the town as anvils. In 1863 Signet was taken to San Francisco and thence transported by way of the Isthmus of Panama to the Smithsonian Institution at Washington. Carleton, weighing 632 pounds, had been removed to San Francisco the preceding year and was afterwards deposited in the hall of the Pioneers' Society in that city.

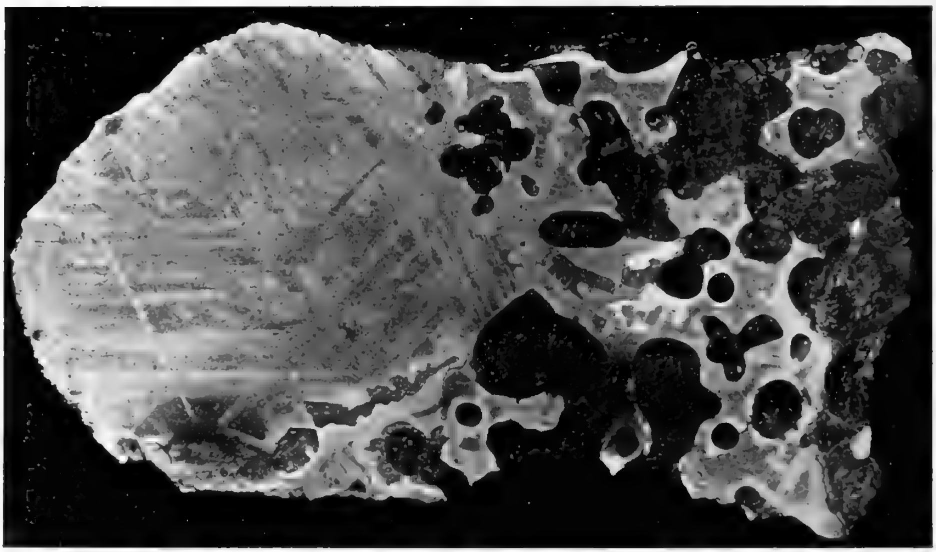
Tucson is classed as a siderite, but its average composition shows the

presence of from 8 to 10 per cent of stony matter included in the nickel-iron, and the proportions of the mineral constituents vary considerably in different parts of the mass. The nickel-iron is an alloy consisting of 89.89 per cent iron, 9.58 per cent nickel, 0.49 per cent cobalt and 0.04 per cent. copper, while the stony matter consists of olivine, carrying an unusual quantity of lime and associated with noteworthy quantities of schreibersite and chromite.

BRENHAM.

(Siderolite.)

Brenham is classed as a siderolite, but some of its fragments are entirely of nickel-iron. The etched section shown in the Foyer illustrates clearly the peculiar texture of the mass. The metallic portions consist



BRENHAM

Siderite (left) and Siderolite (right) in the same piece.

of about 88 per cent. iron, 10 per cent. nickel and 2 per cent. other substances. The dark green and glassy portions are crystals of olivine, which break out from the iron almost entire.

The Brenham meteorite was found in the year 1886 scattered in many pieces on the prairie in Brenham Township, Kiowa County, Kansas, over an area more than a mile in length. The fragments were hardly covered by the original prairie soil, and several of them were projecting through the sod. Nearly all were found by being struck by mowing machines, plows or other farm implements. The occurrence of heavy "rocks" in a region where stones of any kind are a great rarity was a source of surprise to the ranchmen and led finally to the discovery that they were meteoritic in origin.

About thirty fragments of the meteorite have been found, several of which were used for many purposes about the ranches and had a rather prosaic history before their value was learned. The smaller but heavier (75-pound) mass here exhibited was used for years to hold down a cellar door or the cover of a rain barrel, while the larger but lighter (52.5-pound) mass served as a weight on a hay-stack. It is probable that the meteorite of which these are fragments burst soon after reaching the earth's atmosphere. The total weight of all the fragments of Brenham which have been found is about 2,000 pounds; the largest piece known weighs 466 pounds, the smallest an ounce or two.

Other specimens of this meteorite may be seen in the Morgan Hall of Mineralogy on the Fourth Floor.

FOREST CITY.

(Aërolite.)

On Friday, May 2, 1890, at 5:15 P. M., a brilliant ball of fire shot across the sky from west to east in northern Iowa, its flight being accompanied by a noise likened to that of a heavy cannonading, or of thunder, and by scintillations like those of fireworks. The meteoric light was dazzling even in the full daylight prevailing at the time and the noises, which were due to explosions, were heard throughout a district 200 miles in diameter. This meteor was the Forest City meteorite.

The meteorite burst when it was about 11 miles northeast of Forest City, Winnebago County, whence its name, and most of the fragments were scattered over an area about one mile wide and about two miles

long. More than a thousand fragments of this meteorite have been found, most of which weigh from $\frac{1}{20}$ of an ounce to 20 ounces, but a few weigh several pounds. Each is a perfect little meteorite. The largest of the group, which is exhibited here in the Foyer collection, weighs about 75 pounds. The black glassy crust over the surface of all the masses shows that the meteorite exploded early enough in its atmospheric flight for even the smallest fragments to become superficially fused by friction with the air. The fragments show a "primary" and

FOREST CITY.
Shows crust on large and small pieces.

a "secondary" crust, the former formed before and the latter after the bursting of the original mass.

Forest City consists essentially of feldspar, enstatite (a member of the orthorhombic-pyroxene group of minerals), graphite, troilite and nickel-iron. The iron is present in small particles disseminated through the masses and in definite lines suggesting the Widmanstätten figures of a siderite.

The approximate mineral composition of Forest City is

Nickel-iron	19.4%
Troilite	6.2%
Silicates (feldspar, enstatite, etc.)	74.4%

The nickel-iron is an alloy consisting of

Iron	92.7%
Nickel	6.1%
Cobalt	0.7%

The specific gravity of the mass is 3.8. Some chromite is present, but not as much in proportion as is found in the Long Island, Kansas, meteorite.

Some of the smaller individuals of this fall may be seen in the general Museum collection on exhibition in the Morgan Hall of mineralogy (No. 404 of the fourth floor).

LONG ISLAND (KANSAS).

(Aërolite.)

Long Island is the largest stone meteorite known, the fragments which have been recovered aggregating more then 1,325 pounds in weight. The pieces here exhibited weigh together 86 pounds, the largest weighing 32½ pounds. Some of them show the original external surface of the meteorite, but most of them show only fractures. The meteorite was found in more than 3,000 pieces scattered over a gourd-shaped area only 15 or 20 feet long and 6 feet wide in the northwestern corner of Phillips County, Kansas, near the town of Long Island, whence its name. The small area of distribution shows that the mass burst just as it struck the ground, or that it was broken by impact. The late time of bursting is also indicated by the lack of secondary crust on the pieces.

Stony matter makes up about 80 per cent by weight of Long Island, the remainder having originally been nickel-iron and troilite, now partly changed to limonite through rusting. On the polished surfaces of some of the fragments in the case the nickel-iron may be seen as small shining dots. The stony matter consists essentially of the minerals bronzite (one of the orthorhombic pyroxenes), olivine and chromite

and bears a close and interesting resemblance to the terrestrial basaltic igneous rock peridotite. The content of chromite (9 per cent of the whole) is remarkable and is the highest yet reported in meteorites.

Long Island presents a feature heretofore unknown in meteorites. Certain of the planes of fracture show striated surfaces with grooving and polishing (slickensides) due to the parts grinding together in their

LONG ISLAND

Slickensided surface showing movement in the mass before it fell.

flight through space before the mass reached our atmosphere. Two of the pieces in this case show such slickensided surfaces and one of them is illustrated on this page.

Other fine specimens of Long Island may be seen in the general meteorite collection on the fourth floor of the Museum (Hall No. 404).

SELMA

Weight, 306 pounds. Front or "Brustseite."

SELMA.

(Aërolite.)

The Selma meteorite is believed to have fallen at about 9 o'clock, P. M., July 20, 1898, but it was not found until March, 1906. The meteor of July 20, 1898, seems to have traveled in a direction somewhat west of north, and its flight is said to have been accompanied by a heavy rumbling noise and a "trail of fire ten or twelve feet long." The meteorite was found about two miles north-northwest of Selma, Alabama, near the road to Summerfield, and it takes its name from the nearest town, as is the rule with meteoritic falls.

Selma weighs 306 pounds in its present condition, and it is probable that its original weight was about four pounds more, one or more small fragments having been lost from the mass. It is one of the ten largest aërolites ever found, and is the fourth largest aërolite that has fallen in the United States. The others having been broken up, this is probably the largest entire stone meteorite in the country at the present time. Its dimensions are: length, as it rests on its pedestal, 20½ inches; width, 20 inches; height, 14 inches.

In shape Selma is roughly polyhedral without pronounced orientation features, but it is probable that the upper side, as the specimen now lies, was the "brustseite" or front during the flight of the mass through the atmosphere. This side is bluntly pyramidal in shape. The original glassy crust of the meteorite has been mostly decomposed and washed away so that the characteristic thumb-marks, or piëzoglyphs, have been partly obscured. These peculiar markings may be seen on the front of the meteorite and in the illustration on page 37. The mass is deeply penetrated by cracks on both sides, and the position and character of the fissures indicate that they were caused by unequal heating during flight through the atmosphere, the tension produced not being enough, however, to cause complete fracture.

During the years while the meteorite lay buried in the ground alteration due to decomposition advanced considerably. A cut and polished fragment shows the unaltered stone to have a dark brownish-gray color and to be made up of spheroidal "chondrules" firmly imbedded in a matrix of similar matter. The largest chondrules observed are one eighth inch across, but these are extremely rare and most of the

particles have less than half this diameter. Close examination with a strong magnifying glass enables one to see minute grains of iron scattered through the mass. The stony portion of this meteorite consists of olivine, enstatite and a monoclinic pyroxene, while the iron contains a little troilite. The specific gravity is 3.42.

The American Museum Journal

Edmund Otis Hovey, *Editor*

Frank M. Chapman,
Louis P. Gratacap,
William K. Gregory, } *Advisory Board*

Subscription, One Dollar per year. Fifteen Cents per copy

A subscription to the Journal is included in the membership fees of all classes of Members of the Museum.

Guide Leaflets Published by the

AMERICAN MUSEUM OF NATURAL HISTORY

For Sale at the Museum.

(Issued as supplements to The American Museum Journal)

No. 1.— THE BIRD ROCK GROUP. By F. M. Chapman, Associate Curator of Mammalogy and Ornithology. Oct., 1901. 10 *cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. Smith, Assistant Curator of Archæology. Dec., 1901. 10 *cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. Matthew, Ph. D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By Louis P. Gratacap, A. M., Curator of Mineralogy. February, 1902. *Revised edition, May,* 1904. *Price,* 10 *cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. Allen, Ph. D. Curator of Mammalogy and Ornithology. March, 1902 *Revised edition, February,* 1904. *Price,* 10 *cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By George H. Pepper, Assistant in Anthropology. April, 1902. *Price,* 10 *cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By William Beutenmüller, Curator of Entomology. May, 1902. *Price,* 15 *cents.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By George H. Sherwood, A. M., Assistant Curator. November, 1902. *Price,* 10 *cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. Matthew, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition, May,* 1905. *Price,* 10 *cents.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By William Beutenmüller, Curator of Entomology. February, 1903. *Price,* 10 *cents.*

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price, 10 cents.*

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. October, 1903. *Price*. 10 *cents.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRD'S NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted*, February, 1905. *Price*, 10 *cents.*

No. 15.— PRIMITIVE ART. July, 1904. *Price*, 15 *cents.*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price*, 15 *cents.*

(Reprinted from The American Museum Journal.)

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS, AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1905. *Price*, 15 *cents.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Price*, 15 *cents.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price*, 15 *cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Price*, 10 *cents.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price*, 15 *cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Price*, 10 *cents.*

(Published as a separate series.)

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price*, 10 *cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. Price, 15 *cents.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Associate Curator of Geology. December, 1907. *Price* 10 *cents.*

AMERICAN MUSEUM OF NATURAL HISTORY

The Malaria Mosquito

By B. E. DAHLGREN, D. M. D.

Assistant Curator of Invertebrate Zoölogy

GUIDE LEAFLET NO. 27

APRIL, 1908

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

The American Museum of Natural History was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members..........	$ 10	Fellows.......................	$ 500
Life Members.............	100	Patrons......................	1000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year

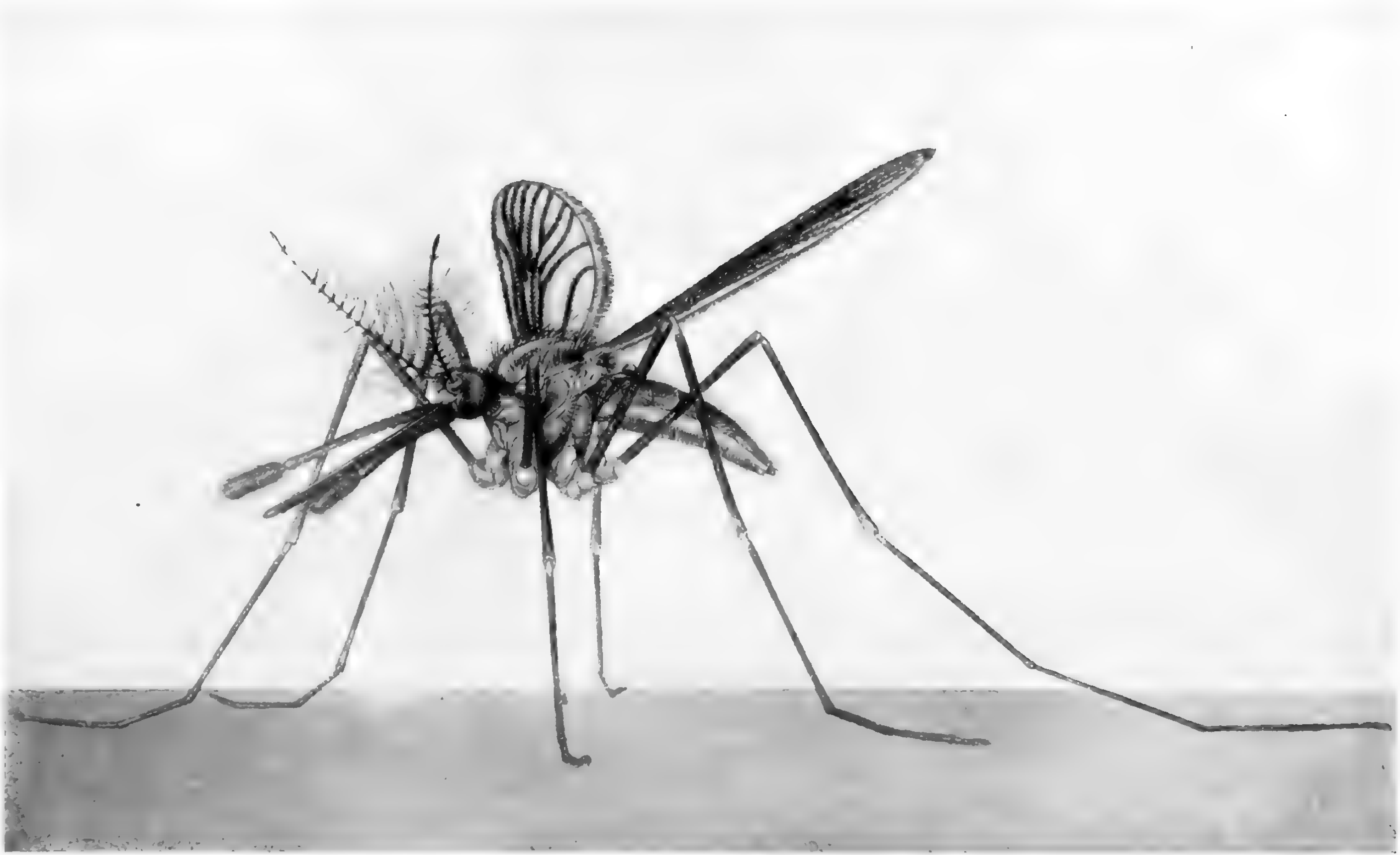


FIG. 1. THE MALARIA MOSQUITO (*Anopheles maculipennis* Meigen). MALE.

From a photograph of the model (× 75) in the American Museum. Magnification of figure about 9 diameters.

The Malaria Mosquito

A GUIDE LEAFLET

EXPLANATORY OF A SERIES OF MODELS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By B. E. DAHLGREN, D. M. D.

ASSISTANT CURATOR OF INVERTEBRATE ZOOLOGY

NO. 27

OF THE

GUIDE LEAFLET SERIES

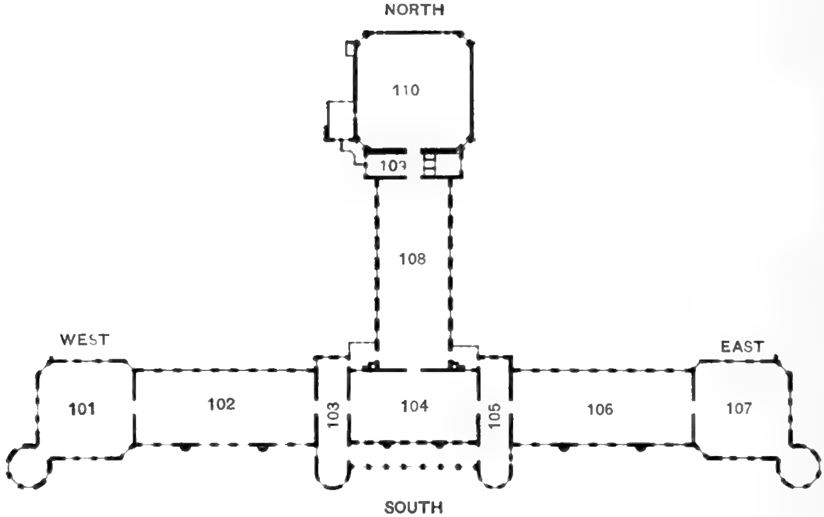
OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. April, 1908

FIRST FLOOR



SKETCH PLAN OF FLOOR.

The series of enlarged models (× 75 diameters) the construction of which led to the studies upon which this Leaflet is based in part were prepared at the Museum by and under the direction of Dr. B. E. Dahlgren, the author of the Leaflet. The models have been placed on exhibition in the middle of the Synoptic Hall, No. 107, at the east end of the ground floor of the building.

EDITOR.

TABLE OF CONTENTS.

THE MALARIA MOSQUITO.[1]

By B. E. Dahlgren, D. M. D.

Assistant Curator of Invertebrate Zoölogy.

Introduction.

THE word "mosquito," supposedly of West Indian origin, is the Spanish diminutive of "mosca," a fly, and the name is correctly applied, since mosquitoes belong to the order of two-winged insects, or true flies, Diptera. They constitute the family Culicidæ, of which some four hundred fifty species are known at the present time.

Distribution

Since the discovery of the agency of mosquitoes in the spreading of malaria and yellow fever, they have received a great deal of attention, and new species are constantly being found. The great majority are tropical, but their range of distribution is nearly universal, extending from the Equator northward and southward, over the temperate zones into the arctic and antarctic regions. About forty species have been described from the neighborhood of New York.

Though mosquitoes occur in general in low and swampy districts, they are also recorded from high altitudes, and Stephens and Christopher in a Report to the Malaria Commission of the Royal Society, state that they are troublesome in the Himalayas at a height of 13,000 feet. A well known malarial species is recorded by them at 5,000 feet. In the United States mosquitoes are numerous not only along the coasts, in the low-lying regions of the South and on the plains and prairies, but also in many places in the woods of the Adirondacks and Rocky Mountains. In Alaska, on the coast of Greenland and on the tundras of the North where other insects are few, they at times constitute a severe scourge, and Arctic explorers relate accounts of mosquitoes on the snow which make a New Jersey swamp seem a desirable resort. Nansen, quoted by Theobald, states that at high latitudes, they literally covered the hands of the voyagers like "rough woolen gloves." In ancient Greece, and in Asia Minor, entire cities[2] were abandoned by their inhabitants, who were

[1] Guide Leaflet No. 27 of the American Museum Series.

[2] Mionte in Ionia, Pergamo in Asia. Howard, Mosquitoes, p. 40.

obliged to flee from the intolerable swarms of gnats that descended upon them.

Dissemination

Certain artificial agents seem to play some rôle in the dissemination of mosquitoes. Railway trains are said to be responsible for the distribution of the insects, and tracts which have been practically free from the pest are thought to have been invaded as the railroad lines opened up the country. One species occurring in Australia is supposed to have been "imported from Europe in the watertanks of some old sailing vessel."[1] At the port of New York a

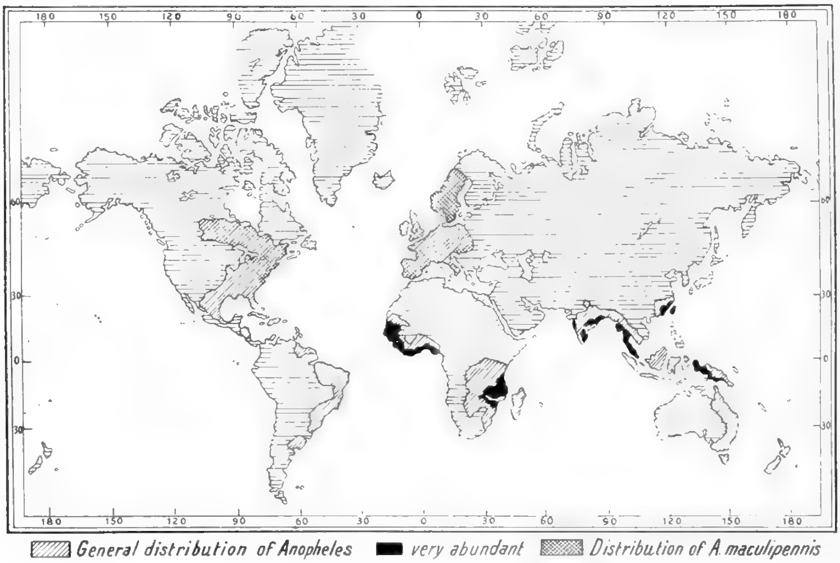


FIG. 2. THE DISTRIBUTION OF ANOPHELES
After Theobald.

dozen foreign species have been observed on ships in quarantine. Mosquitoes are also carried by the wind. The fact that hosts of adult mosquitoes are to be found in localities where not a single larva of the species may be discovered, led Professor John B. Smith, of New Jersey, to investigate the question of migration of mosquitoes, and he has learned that large swarms of them may, with a moderate wind, fly or drift thirty or forty miles. Shore mosquitoes are found far inland, and, on the other hand, swarms have been seen many miles out at sea.

[1] Skuse, as cited by Theobald, Culicidæ of the World, Vol. 1, p. 82.

The number of mosquitoes in a large swarm is beyond comprehension, and accounts of "immense clouds filling the air"— "like a column of smoke," or "like a dense wall, miles in length," are by no means infrequent. L. O. Howard,[1] Chief of the Bureau of Entomology at Washington, describes a swarm observed in Texas, the main body of which was three miles wide, and which required nearly five days to pass a given point. Such migrations of mosquitoes, though they are usually on a smaller scale, account for the sudden appearance of the insects in areas from which they were previously absent, and their equally sudden disappearance.

Mosquito Swarms

As a rule, mosquitoes are frail insects and weak flyers. In rain or winds they hastily seek shelter. The Malaria Mosquito (*Anopheles*) avoids places where draughts exist, and seldom flies more than a few hundred yards. An Indian species of the genus is known which flies a quarter of a mile, but rarely as far as half a mile. The Malaria Mosquito as a rule, spends its entire life in the immediate neighborhood of human dwellings.

Habits

Mosquitoes are most active at early dawn and after sunset. They seem in general to avoid strong light and to prefer dark colors. The hours of daylight are spent by most species hiding in some secluded spot in a tuft of grass or a bush, while the Malaria Mosquito finds some dark corner indoors, where it passes the day. There are, however, some notable exceptions to this general rule. The Yellow Fever Mosquito flies at almost any time of day, except noon, and several tropical species resemble it in this respect.[2]

In the autumn all the males die, while the fecundated females seek winter quarters. The Malaria Mosquito, which is essentially a house mosquito, may be found hibernating in dark corners in cellars, sheds or attics. The strictly out-of-door species find winter quarters in the woods or in the fields. In the arctic regions mosquitoes find suitable hibernating places under moss. Large numbers of the insects undoubtedly perish during severe winters, but, under ordinary conditions, enough mature females survive to furnish locally the first brood of the following season. A warm day in early spring brings the insects out of their stupor; on a sunny day in mid-winter

Hibernation

[1] Mosquitoes, How they live, etc., p. 22. See also Theobald's Monograph of the Culicidæ of the World for several interesting accounts.

[2] One of the local species of Anopheles (*A. crucians*) is a "daylight mosquito."

they may occasionally be seen on the snow. In tropical countries the dry season is the period of inactivity for the mosquitoes.

Food

The food of mosquitoes consists ordinarily of the nectar and juices of plants and fruits. This is always true of the males, whose mouth-parts are not at all adapted for stinging. In certain species neither sex seems to have any taste for blood, while on the contrary, it is well known that mosquitoes living far in the woods, in the swamps, or in the Arctics where their chances of obtaining a meal of blood may be almost infinitesimal, nevertheless, will seize greedily upon the opportunity when it offers. It has been thought that a full meal of human blood is necessary for the female Malaria Mosquito, in order that she may lay her eggs, but this is certainly questionable. Theobald maintains that, in England at least, the Malaria Mosquito seldom sucks blood. Mosquitoes of sanguinary taste by no means confine themselves to human, or even mammalian blood, they suck with eagerness the blood of birds and reptiles whose skin they may be able to pierce. They have frequently been observed feeding upon other insects and on caterpillars. Howard asserts that they will attack small fish when these come to the surface of the water. In captivity, mosquitoes are fed with success on slices of banana or apple. They require water, but may exist for months without any food whatever. On the other hand, they may feed as often as they have opportunity, though several hours are required for the digestion of a full meal.

Length of Life

The average length of life of female mosquitoes is not less than a month or two, but hibernating females must live at least six or even eight months. The life of the males is much shorter, and may not exceed a few days in duration. The point is difficult to determine, since in captivity death may be the result of various artificial conditions. To compensate for the shortness of life of the males, they greatly outnumber the females. In several broods hatched in aquaria in the Museum the ratio of males to females was eight or nine to one. Since a recently hatched mosquito becomes full grown in two or three days, and it may lay its first batch of eggs within a week, there may be as many as a dozen or more generations in the course of a year, in favorable localities, but seasonal conditions necessarily exert great influence on the number of broods. In dry climates breeding is confined to the rainy season, in humid tropical climates it may extend throughout the greater part of the year, while in

9 Courtesy of J. B. Smith.

FIG. 3. MOSQUITO-BREEDING POOL ON CAPE MAY.

This pool, with an area of 1,894 square feet, had a population of ten and a half millions of mosquito larvæ (*Anopheles crucians* Wied), the sixth brood of the season. (Smith, Report on Mosquitoes, p. 403.)

the Arctics it must naturally be very short. In temperate climates the first brood generally appears in April or May, while in October and November the fecundated females seek their winter quarters.

The female mosquito lays its eggs, from fifty to two hundred in number, on the surface of any convenient quiet body of water. Certain mosquitoes prefer to lay their eggs on brackish water. Thus, the females of *Culex cantator* and *C. sollicitans*, both salt-marsh mosquitoes, which were found by Professor Smith in inland swarms, were observed returning to the shore with developed ovaries, and this seemed to him "in the nature of a return migration for oviposition."

Breeding places

Though mosquitoes of the various species may differ widely in many minor details such as size, color, form of scales and markings on the body, wings and legs, in all essential respects of structure and life-history they are similar. The following description, however, applies particularly to the local Malaria Mosquito (*Anopheles maculipennis* Meigen), which is represented by a series of large-scale (× 75 diameters) models in the Museum. Other mosquitoes are treated of incidentally, as they differ from the Malaria Mosquito in some important respect.

The Malaria Mosquito.

The Egg.

Mosquito eggs are minute bodies, measuring only one half to one millimeter (one fiftieth to one twenty-fifth of an inch) in length. They are generally ovoid in form, but the particular configuration of their covering, or shell, of chitin varies considerably in different species. The egg of Anopheles (Fig. 4) is boat-shaped with one end somewhat pointed, the other rounded. The lower surface, the bottom of the boat, is strongly convex and reticulated, the upper surface, the deck, is more flattened. The egg is provided on the sides with corrugated air chambers which serve as floats. When recently laid the eggs appear almost white in color, but they darken rapidly and in a few hours become nearly black.

Anopheles Eggs

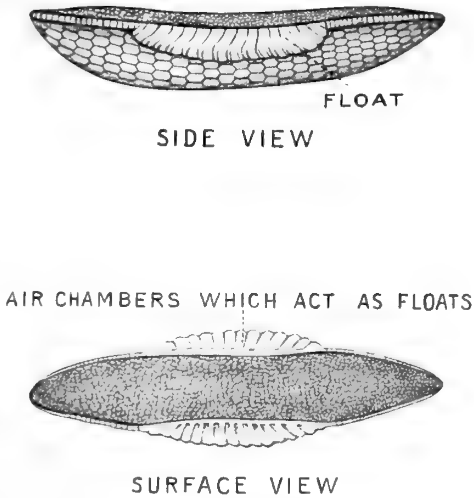
Arrangement of Eggs

In the process of deposition the eggs of the Common Mosquito unite to form raft-like masses, which are known as "egg-boats" or "floats" (Fig. 5). The eggs of Anopheles, however, are deposited separately, but they may be found arranged in various patterns on the surface of the water, forming

star-shaped groups or adhering side by side to make miniature pontoon-bridges (Fig. 6). The eggs of certain species are never laid on water, but on mud, perhaps at the edges of pools, and are said not to develop at all, unless they be left dry for at least twenty-four hours.

Resistance

The eggs of some mosquitoes will survive drying for two or three months, while those of others with a thinner chitinous shell, easily perish if the mud or water of the pool in which they have been laid dries up. Ordinarily, mosquito eggs are not resistant to cold and will not survive freezing, though those of some species are actually known to hibernate.



FROM NUTTAL AND SHIPLEY

FIG. 4. THE EGG OF THE MALARIA MOSQUITO.
Magnification about 60 diameters.

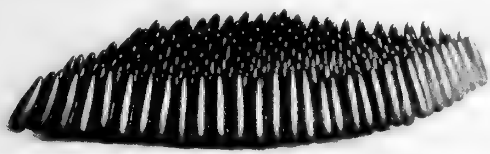
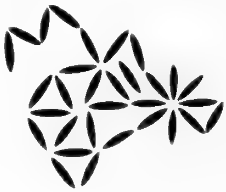


FIG. 5. "EGG-RAFT" OR EGG-BOAT OF THE COMMON HOUSE MOSQUITO (*Culex pupiens* Linn.).
Magnification 12 diameters.

Hatching

When the eggs are ready to hatch, in about two to four days after they are laid, a small cap-like portion of the envelope bursts off at the rounded end of the egg and the larva escapes.

In the "egg-boats" of Culex the rounded end of each egg is directed



STAR SHAPED ARRANGEMENT.

PONTOON BRIDGE ARRANGEMENT

AFTER GRASSI

FIG. 6. EGGS OF THE MALARIA MOSQUITO

Characteristic arrangements on the surface of the water. Magnification 7 diameters.

downward and the larvæ escape into the water from the lower surface of the float (Fig. 7).

The Larva.

Mosquito larvæ are popularly known as "wigglers" or "wrigglers," because of their peculiar motions in swimming. At the time of hatching, the larvæ of the Malaria Mosquito are minute. The transparent body is cylindrical and is exceeded in diameter by the small, brownish, rounded head. As soon as freed from the egg the larva begins to feed. It grows rapidly, and, if the food supply is abundant and the temperature of the water is not too low, it attains its full size in a few days. The body is divided into the head, the thorax and the cylindrical abdomen of nine rings or segments (Fig. 8). In a newly

Divisions of the body

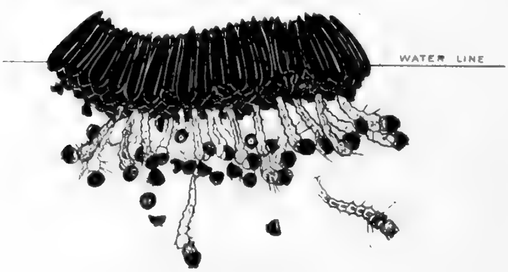


FIG. 7. MOSQUITO LARVÆ (*Culex pipiens* Linn.) HATCHING FROM AN "EGG-RAFT".

The escaping larvæ are carrying on their heads the cap-like lower ends of the egg shells. These caps may be seen attached, like hinged lids, to some of the eggs of the raft, and this is the usual condition. The egg-raft was in this case disturbed, and the instant and simultaneous hatching of the larvæ occurred with such sudden violence that the lids were carried away on the larvæ heads. Magnification about 12 diameters.

FIG. 8. THE LARVA OF THE MALARIA MOSQUITO (*Anopheles maculipennis* Meigen).
Photograph of the model (× 75) in the American Museum. Magnification of the figure about 20 diameters.

hatched larva the latter regions can hardly be distinguished from each other, but as the larva grows the three fused segments of which the thorax consists become enlarged and flattened. Legs are absent, but both thorax and abdomen bear a great number of symmetrically placed pairs of branched feather-like hairs, arranged in a manner characteristic of the species. These hairs project laterally and aid in maintaining equilibrium, but they undoubtedly serve other purposes too, being also organs of touch and possibly of respiration. Similar, but smaller, hairs are found on the back of the head, and many very small, simpler hairs are distributed over the whole body, particu-

Appendages

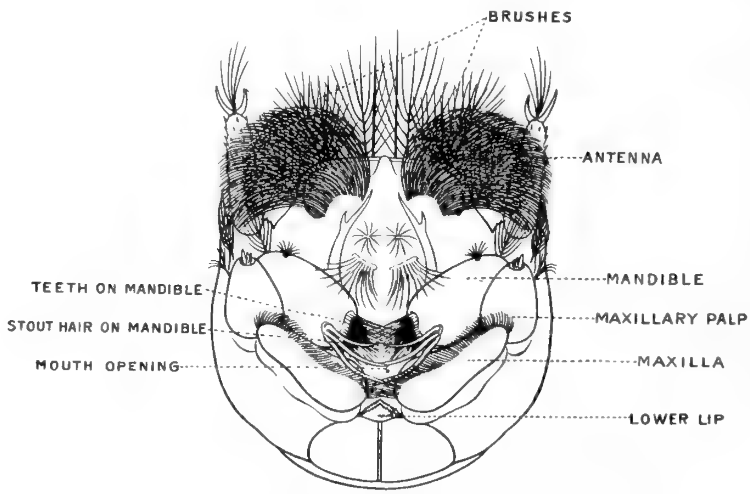


FIG. 9. HEAD OF ANOPHELES LARVA, SHOWING MOUTH-PARTS

Ventral view. Magnification 45 diameters.

larly along the back and sides. On the back of the abdomen are five or six pairs of dark-brown palmate structures, which float on the surface of the water, when the larva is at rest, and aid in maintaining the horizontal position of the body which is characteristic of larvæ of the genus Anopheles.

The next to the last segment bears on its upper side the short "siphon," which reaches the surface of the water, when the larva floats in its usual position. In the siphon are the openings of the two main tracheæ, or respiratory tubes. The larva is strictly air-breathing and does not normally remain away from the surface of the water, except

when disturbed, and then only for a short time. That the larva must have air in order to live makes possible its destruction by means of a film of oil spread on the surface of the water. The oil, acting mechanically, closes the openings in the respiratory siphon and causes the larvæ to die from suffocation. If oil is poured on the surface of an aquarium in which the larvæ are kept, they may be seen, after an instant's contact with the film, in frantic contortions, as they strive to free themselves from the oil, lashing the end of the abdomen about and even desperately biting the tip of the siphon.

Effect of Oil

The last segment of the abdomen has terminally two pairs of bristles and four elongated sac-like appendages with very thin walls, the "blood-gills." On its under side it bears a large fan-like arrangement of branched hairs which seems to serve as a keel or rudder.

THE MALARIAL MOSQUITO LARVA
ITS USUAL POSITION IS HORIZONTAL AND AT THE SURFACE OF THE WATER.

THE COMMON WRIGGLER
ITS USUAL POSITION IS OBLIQUE, AND THE TIP OF THE SIPHON ALONE REACHES THE WATER.

FIG. 10. CHARACTERISTIC POSITION OF LARVÆ OF MALARIA AND COMMON MOSQUITO.

The head of the mature larva is large and rounded and is brown in color. It is united to the thorax by a membranous neck which allows considerable freedom of movement. Its upper surface is characteristically marked by dark-brown spots and bears rows of branched hairs. On the sides of the head are the antennæ extending forward, and behind these are the eyes. In front, on the under side and over-hung by the elongated anterior portion of the head, is the mouth, which is surrounded by a formidable armature (Fig. 9). Overhanging the mouth-parts and at the most anterior part of the head are two moustache-like brushes. Below these and behind them are two mandibles which move laterally and bear strong spine-like teeth for crushing food. On either side of the mandibles project the cylindrical maxillary palps, and below the mandibles are the flattened maxillæ beset with fine hairs. Below all of these mouth-parts is the small triangular so-called "lower lip."

Head of larva

1

2

FIG. 11. TYPICAL BREEDING PLACES

1 A suburban scene with a neglected gutter (from J. B. Smith, Report on Mosquitoes). 2. A pool on an "unimproved" lot on Broadway, New York City.

Anopheles larvæ exhibit a curious habit of suddenly twisting the head. The peculiar, almost audible "snap" or "click" with which the sudden turning is accomplished is very characteristic. On this account the name "head-turners" has been proposed for them.[1]

Manner of feeding

The larva feeds with its head turned so that the lower side, which bears the mouth, is directed upward. The moustache-like brushes, by rapidly sweeping the under side of the surface-film of the water, set up a current which carries food into the mouth. Small particles which become entangled in the brushes are combed out by stout curved hairs, three or four of which are borne on each mandible, the brushes bending back into the mouth for this purpose from time to time.

Food of Larva

The food of the larva consists of the microscopic animals and plants which abound at the surface of the water. Little discrimination seems to be exercised in the choice of food, anything which is carried into the mouth, even sand grains, being sometimes voraciously swallowed. The intestine, which is practically a straight tube, may usually be seen in the rather transparent living animal, colored dark by its contents. The entire larva often appears green from ingested algæ.

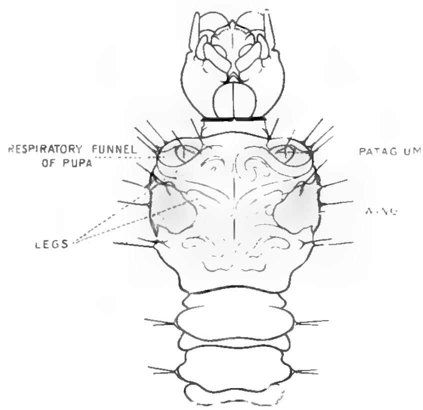


FIG. 12. MATURE LARVA OF ANOPHELES

Ventral surface. The figure shows clearly the formation of the thorax of the future insect within the larval thorax. Magnification, 13 diameters.

The Malaria Mosquito larva may be readily distinguished from the larva of the Culex Mosquito by the shortness of its siphon and its horizontal position in the water. The common "wrigglers" have elongated siphons and are always found hanging obliquely, or even vertically, head downward, the tip of the siphon only reaching the surface (Fig. 10).

Hibernation

The larvæ of certain mosquitoes are known to hibernate, and may remain throughout the winter frozen in the ice, coming to life when the ice melts in the spring. Professor Smith

[1] Minot, C. S. Notes on Anopheles. Boston Soc. Med. Sci. 1901.

gives an account of having repeatedly obtained certain mosquito larvæ in large quantities, by thawing out ice which had formed in the leaves of the pitcher plant (*Sarracenia*).[1] When pools in which the wrigglers live dry out, the larvæ usually perish in a short time. They are most likely to be found in small and undisturbed bodies of water, such as accumulate in little hollows between tufts of grass, in meadows, or in ditches where there is no perceptible flow (Fig. 11). Where there is any current in the water the larvæ are easily swept away, and those that occur in moving water are always found along the edges of the stream, where they are out of reach of the current. Cat-tail swamps are said to be practically free from mosquito larvæ, probably because of the usual presence in them of small fish. Such places as neglected tin cans or broken bottles, rain barrels, cisterns and deep wells may be swarming with larvæ. Dr. Howard mentions a case where the census of the inhabitants of a rain barrel was taken. In one month it yielded 36,369 mosquito eggs, larvæ and pupæ.[2]

Number

The duration of the larval stage is usually from seven to fourteen days. During this time the various parts of the adult insect are in process of formation under the larval skin (Fig. 12). In older larvæ the adult eye, for instance, may be seen as a crescentic dark mass lying near the larval eye. The legs and wings of the future "fly" may be seen forming within the larval thorax. The formation of adult structures is accompanied by destructive changes in the strictly larval internal organs and tissue. In due time, when this process has proceeded far enough, a T-shaped split occurs in the back of the larval skin and through this the insect emerges as a pupa.

The Pupa.

The pupa which escapes from the larval skin forms the next stage in the development of the insect (Figs. 13 and 14). It too is aquatic in habit and ordinarily leads a brief and comparatively quiet life. It does not feed. When at rest, it floats at the surface of the water, breathing through a pair of funnel-like tubes. It is, however, able to execute very rapid, though jerky, movements and

Habits of Pupa

[1] John B. Smith, N. J. State Agr. Exp. Station. Report on Mosquitoes, p. 346, 1905.

[2] L. O. Howard, Mosquitoes, p. 44.

darts downward instantly when disturbed. If confined in a glass vessel, it may be seen on such occasions to strike the bottom repeatedly, returning to the surface of the water by its own buoyancy as soon as its movements cease. The downward swimming is accomplished by a few vigorous strokes of the strongly curved abdomen, which bears at its tip a pair of "paddles," or "flippers," and is the only freely movable part of the body.

FIG. 13. THE PUPA OF THE MALARIA MOSQUITO. FEMALE

Photograph of the model (× 75) in the American Museum. Magnification of the figure about 15 diameters.

Structure of Pupa

Under the transparent integument of the pupa may be seen outlined the body and appendages of the developing mosquito (Fig. 15). The head is drawn up against the anterior part of the thorax, giving the pupa its characteristic hunchbacked appearance. The strongly flexed abdomen curves downward and forward under the thorax. The elongated mouth-parts, the "proboscis" of the

future fly, lie directed downward and backward in the median line, forming a "keel" just beneath the thorax. The legs are bent at the knee-joints and lie pressed against the thorax on each side, then they turn backward and terminate in S-shaped curves under the fore part of the abdomen. They are partly concealed by the wings, which hang, cramped in their wing-cases, closely pressed against the body on each side of the thorax. Arising from the anterior third of the thorax in front of the attachment of the wings, are the respiratory tubes terminating in funnel-like expansions which spread out on the surface of the water when the pupa is in the ordinary position of rest. In respect to the position of its respiratory openings, the pupa differs decidedly from its

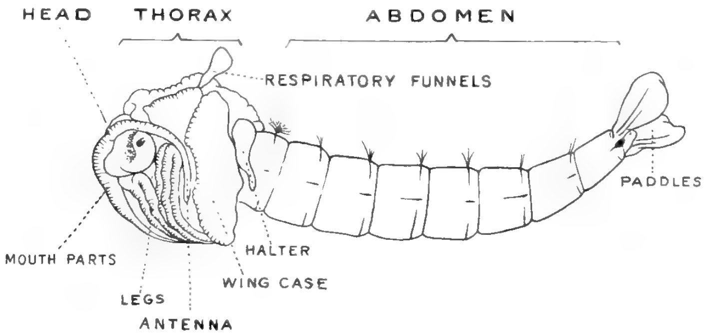


FIG. 14. THE YOUNG PUPA OF ANOPHELES

The abdomen of the emerging pupa is straight or with a slight upward curve. The strong downward abdominal flexure of the older pupa becomes established a few hours later. Magnification 12 diameters.

predecessor, the larva, which has its siphon near the end of the abdomen. Like the larva, it is easily destroyed by anything which interferes with its free access to the air. Curving backward from the head, above the legs and in front of the wings, are the two antennæ. Below the origin of the antennæ lie the two palps, with sharply S-shaped flexures.

Duration of Pupal Life

The duration of the pupal stage is usually from two to four days, but it may, under unfavorable conditions of temperature, be prolonged to weeks. On the other hand, the threatening danger of a drought or the presence of a disagreeable substance in the water, such as the phinotas oil used for destroying mosquitoes, may very much hasten the emergence of the fly.

The pupa represents that period in the metamorphosis of the insect

during which the internal changes begun in the larva, which are to result in the formation of the adult mosquito, are continued and completed. Under the pupa skin a new integument is secreted which becomes the final external covering of the fly. Its appendages, hairs and scales may be seen fully developed in late pupal stages like the one represented in the model as shown in Fig. 13.

Formation of the Adult

When the formation of the mosquito fly is complete, the pupa skin bursts along the middle of the back and the adult extricates itself from its floating case. At this "critical period," large numbers of mosquitoes perish, because, until their legs and wings are thoroughly hardened, a slight gust of wind or a ripple of the water will upset and drown them. This makes it possible to bring about the artificial destruction of a large proportion of the insects, through the simple introduction of tidewater into mosquito-ridden marshes.

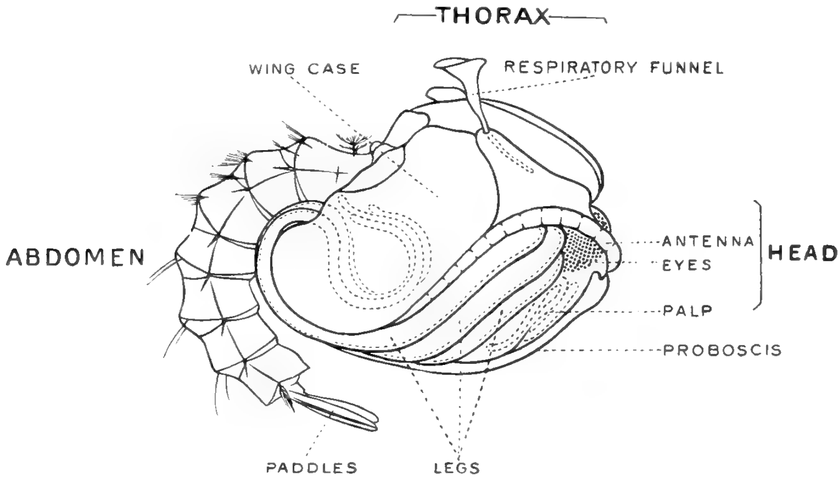


FIG. 15. THE FULL-GROWN PUPA
Magnification about 12 diameters.

The Adult Mosquito.

The smallest of the local mosquitoes measures not more than 1.5 mm., while the largest, perhaps, the famous "Jersey mosquito" (*Psorophora ciliata*), called "Gallinippers" in the South, attains a length

Size

of 8 to 10 mm., — almost half an inch. The Malaria Mosquito is from 6 to 8 mm. long.

Body-covering

The body of the mosquito, like that of all other insects, is covered with a dense, though very thin, continuous layer of a hard substance, "chitin," secreted by the true, cellular skin, or hypodermis, which lies underneath it. The chitin not only affords protection to the body, but also gives support to the limbs and wing-veins and forms in fact an external skeleton, on the inner side of

FIG. 16. AN ANOPHELES MOSQUITO EMERGING FROM ITS PUPA CASE

Head, thorax and abdomen are free, but the wings are not entirely freed and the long legs are still partly coiled within their pupal integument. Photograph from life, greatly enlarged.

which the muscles of the insect are attached. Wherever rigidity is required, the chitinous coat is thickened, but elsewhere it remains thin to permit movement of the body segments.

Divisions of Body

Three main regions of the body may be easily distinguished, the small rounded head with its appendages, the relatively large thorax, and the elongated abdomen (Figs. 1 and 17). The head, which is connected with the body by means of a rather slender neck,

bears the mouth-parts and special sense-organs. The thorax, which consists of three closely consolidated segments, bears the organs of locomotion, the legs, one on each segment, the wings on the middle segment and a pair of minute balancers on the third. The abdomen is distinctly segmented and consists of eight rings, but, except on the terminal segment, it bears no appendages. The almost spherical head is somewhat flattened in front.

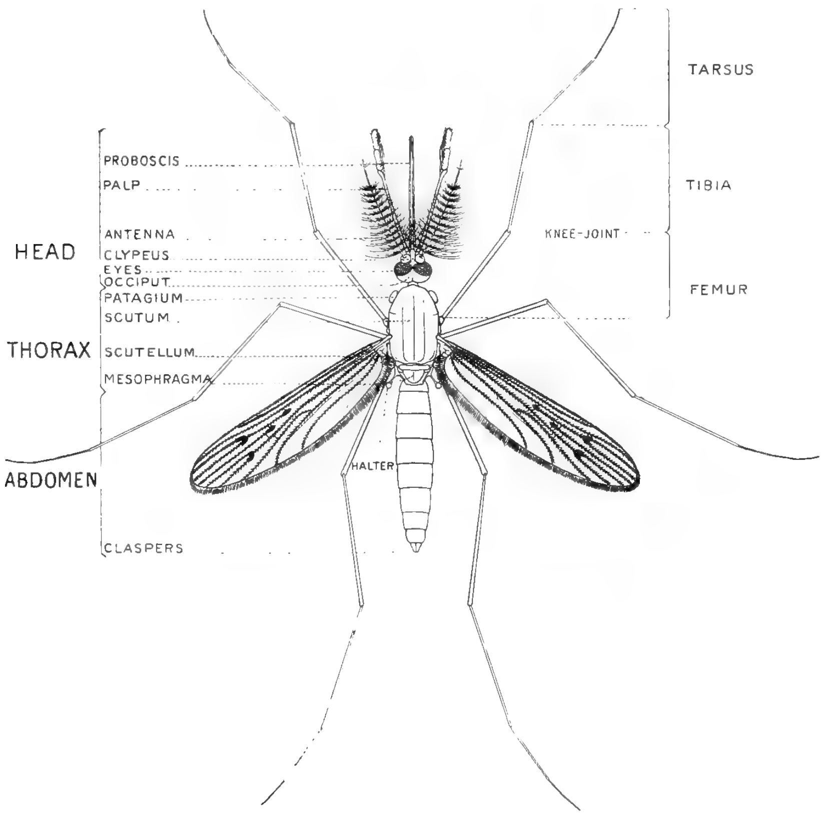


FIG. 17. MALARIA MOSQUITO. MALE.
Magnification 7 diameters.

Head

The anterior portion of the head is occupied by two large compound eyes, each composed of several thousand simple eyes or facets, regularly arranged and so closely crowded together that their outlines appear hexagonal. In such compound eyes each separate facet receives rays of light from only a single direction, but the great number

of facets distributed over a spheroidal surface makes it possible for the mosquito to see in almost every direction.

Antennæ

In front of the eyes are the antennæ, two slender organs, with a central jointed axis of 15 or 16 segments, each bearing a whorl of fine hairs. The antennæ are organs of hearing, and by means of them the male is able to detect the presence of the female. If the "song" of a female mosquito be imitated with a tuning fork, the antennæ of the male mosquito, which support long and exceedingly delicate whorls of hairs (Fig. 1), that respond to every vibration of the air, may be seen to bend in the direction from which the sound proceeds.[1]

Below the antennæ, at the very front of the head, are the mouth-parts,

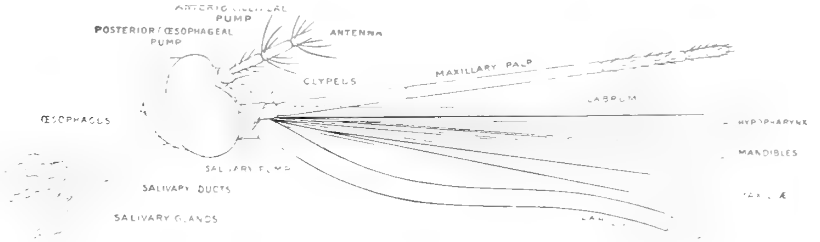


FIG. 18. HEAD OF FEMALE MALARIA MOSQUITO.

Proboscis of Female

constituting the so-called "proboscis" (Fig. 17). This consists of several members. The principal one, lying above all the other mouth-parts, is the "labrum," deeply grooved along its lower side.[2] Under the labrum there is a delicate chitinous lamella, the "hypopharynx." The hypopharynx is closely applied to the labrum along its entire extent, and by closing the groove therein from below, forms therewith the tube through which the mosquito sucks up blood or other liquid food (Fig. 19). A fine tubular channel which runs along the median line of the hypopharynx serves to conduct the poison that the mosquito pours into the wound when sucking blood. Along the sides and below the tube, composed of these two mouth-parts, there are two pairs of very slender chitinous rods, expanded at the ends into lancet-like blades set with fine teeth. One pair, the "mandibles," are exceedingly delicate; the other, the "maxillæ," are stouter and have

[1] Mayer, A. M. Researches in Acoustics. Am. Jour. Sci. and Arts. III, viii, p. 81. 1874.

[2] The "labrum" is undoubtedly a compound structure and properly is the "labrum-epipharynx."

larger teeth. These latter pairs of instruments enter the wound made by the point of the labrum, and with their saw-like blades, serve to brace the head while the "sucking-tube" is thrust forward. By a to-and-fro motion which alternates with that of the piercing tube, they are pushed into the tissues together with the tube, and their fine teeth undoubtedly also serve to lacerate the tissues in the wound and to produce an increased flow of blood at the point of the sucking-tube.

All these mouth-parts, *viz.*: the labrum, the hypopharynx, the mandibles and the maxillæ, form a very compact bundle which, when not in action, is almost entirely contained in a groove on the upper surface of the lower lip or "labium" (Fig. 19). This is attached below the base of the other mouth-parts. It is equal to them in length, but much larger than all the others taken together, and is flexible and forms a sheath which serves for their protection. Its outer surface is beset with scales. Of the whole bundle of mouth-parts only the labium and upper surface of the labrum are ordinarily visible. At the tip of the labium, two small pointed movable flaps, or "labellæ" are hinged (Figs. 18 and 26), which protect the points of all the mosquito's delicate surgical instruments, when these are not in use. The separation of these flaps exposes the points ready for instant action (Fig. 26). The female alone sucks blood. In the male the maxillæ are lacking, and the tip of the labrum is blunt and unfit for piercing.

Proboscis of Male

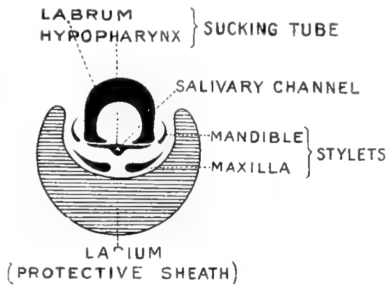


FIG. 19. CROSS SECTION OF THE PROBOSCIS

The mouth-parts, which are represented in solid black, are those which the insect actively employs in stinging. Female.

The first, though somewhat erroneous, account of the mouth apparatus of the mosquito is contained in Swammerdam's "Bybel der Natuure" (1668) published in Holland in 1738. In 1739, the French scientist Réaumur published a description of the mosquitoes' manner of biting. His illustrations, here reproduced (Fig. 20), show well how the soft labrum is pushed away and flexed in biting, and how only the labellæ remain in contact with the stylets at the point of their entrance into the wound.

Manner of Stinging

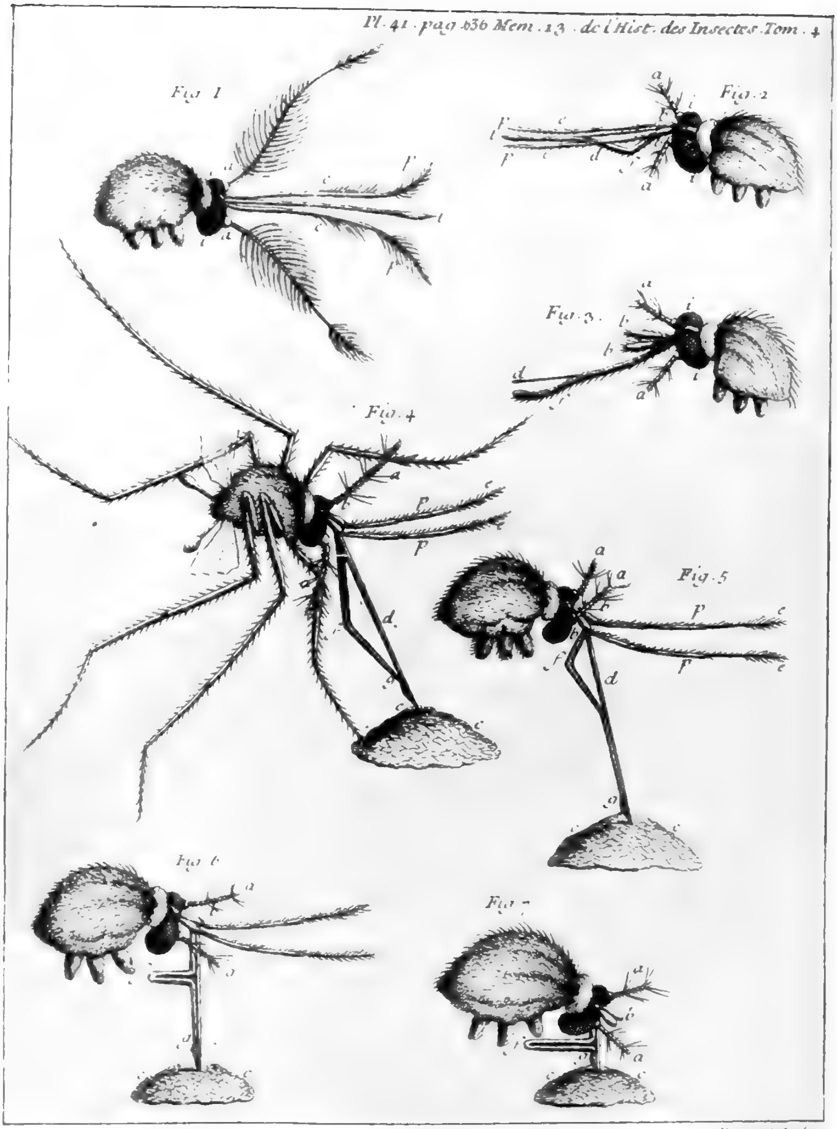


FIG. 20. HEAD AND THORAX OF THE MOSQUITO

Fig. 1. Male. Figs. 2–7. Females, 4–7, in the act of stinging. Reproduction of a plate in Réaumur's Mémoires pour servir à l'histoire des Insects, 1739.

The Palps

On either side of the proboscis there are two long pointed appendages of the maxillæ, the maxillary palps, which serve as organs of touch. In the female Malaria Mosquito they are slender and of uniform thickness; in the male the terminal segment is enlarged and bears long hairs (Figs. 21 and 22). In both sexes of the Malaria Mosquito the palps are long, equal in length to the proboscis, and covered with fine scales. In the common Culex Mosquito, the palps of the female are short (Fig. 21), not more than half the length of the

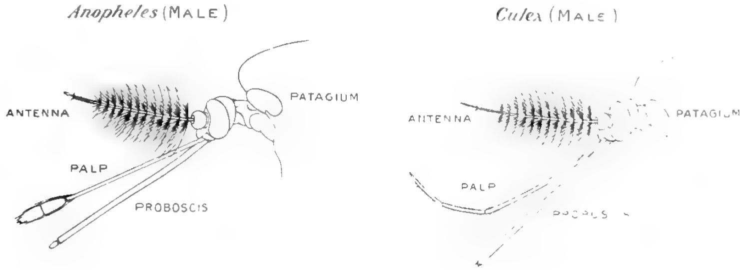


FIG. 21. THE MALARIA AND THE COMMON MOSQUITO. MALE.
Suggested by figures of Eysell, in Arch. für. Schiffs- u. Tropenhygiene.

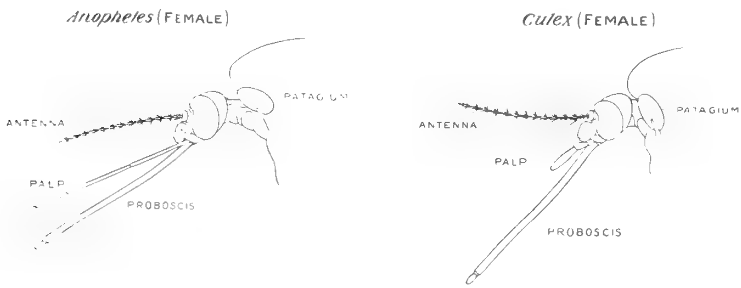


FIG. 22. THE MALARIA AND THE COMMON MOSQUITO. FEMALE
Suggested by figures of Eysell, in Arch. für Schiffs- u. Tropenhygiene.

proboscis; those of the male are long, but their terminal segment is not enlarged, though set with long hairs (Fig. 22). This furnishes a ready means of distinguishing the Malaria Mosquito from the Culex.

The margin of the chitin bordering on the eyes, appears white or light gray in color. Just behind the light margin is a row of long hairs, which overhang the eyes, and in front a tuft of long hairs and scales overhang the space between the antennæ. The remainder of the head is covered with scales.

The slender and almost transparent neck connects the head with the second division of the body, — the thorax. This is greatly enlarged to accommodate the strong wing-muscles which it contains (Fig. 26). The middle segment, which bears the wings, exceeds the other in size and forms the entire dorsal portion of the thorax.

Wings

The delicate membranous wings are strengthened by ribs, or veins, closely beset with scales. The arrangement of scales varies in the different species of mosquitoes. The local Malaria Mosquito is distinguished by the presence of four dark spots in certain characteristic positions on its wings, and hence its specific name "maculipennis," or "spotted-winged" (Fig. 23). These spots are produced by the grouping of the scales of the wing veins into dense tufts at these points. The margin of the wing bears several rows of scales, long

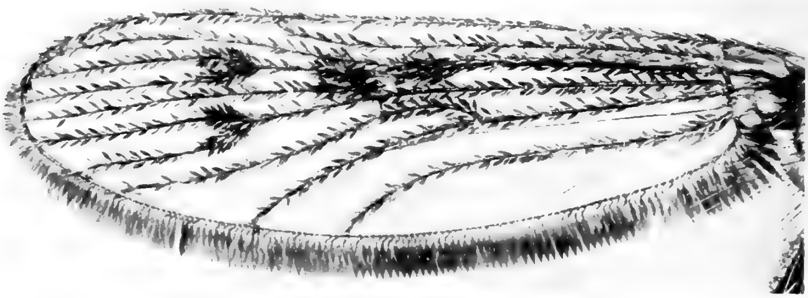


FIG. 23. WING OF ANOPHELES MACULIPENNIS MEIGEN.
Magnification about 20 diameters.

and slender scales alternating regularly with rows of shorter ones, producing a beautiful fringe.

A pair of small club-shaped organs, the "halteres," or balancers, on the third segment of the thorax, enables the insect to maintain its equilibrium, for without them it performs aimless evolutions in the air somewhat after the fashion of a tumbler-pigeon, and it cannot direct its flight. Similar organs are found in all Diptera and they represent a degenerated second pair of wings.

Legs

Each of the segments of the thorax bears a pair of legs. Structurally these are simply hollow, jointed tubes of chitin containing the muscles by which they are flexed. Externally they are covered with scales, and in certain places they bear fine hairs. The legs are

connected to the body by the "coxæ," or hip-joints, which are constructed so as to permit great freedom of movement (Fig. 26). Then follows in each leg, a small piece, the "trochanter," uniting the coxa with the leg proper. Each leg consists of seven pieces. The first is called

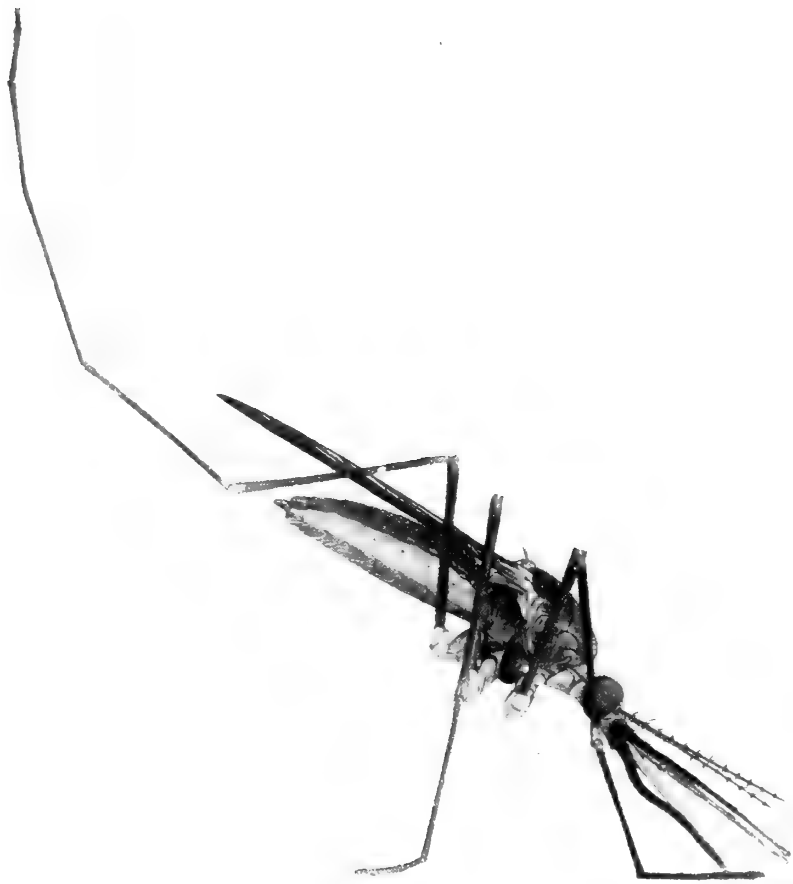


FIG. 24. FEMALE ANOPHELES IN CHARACTERISTIC STINGING POSTURE

Photograph of the model (× 75) in the American Museum. Magnification of figure about 10 diameters.

the femur, the second is the tibia, then follow the tarsal joints, five in number, the last of which bears a pair of claws. In the male one of the claws of each foreleg is greatly enlarged. When the mosquito walks or

rests, it supports itself on several of the tarsal joints. The legs of the third pair are, however, used very slightly in walking, but they serve continually as organs of touch, and in flight they help to balance the body and determine its inclination. They are often carried raised and curved forward over the body especially when the mosquito is stinging (Fig. 24).

Abdomen

The abdomen is closely united to the thorax. Its eight rings, or segments, are each composed of an upper and a lower shield of chitin and a soft connecting membrane. This soft "pleural membrane" permits of movements of respiration, as well as of the very considerable distension of the abdomen noticeable in mosquitoes after a full meal. The abdomen tapers gradually toward the tip, and the last segment in the female mosquito bears the ovipositor by means of which the eggs are laid and, with the aid of the hind legs, arranged on

Anopheles.
BODY AT AN ACUTE ANGLE TO THE SURFACE ON WHICH THE INSECT RESTS.

Culex
BODY PARALLEL TO THE SURFACE ON WHICH THE INSECT RESTS

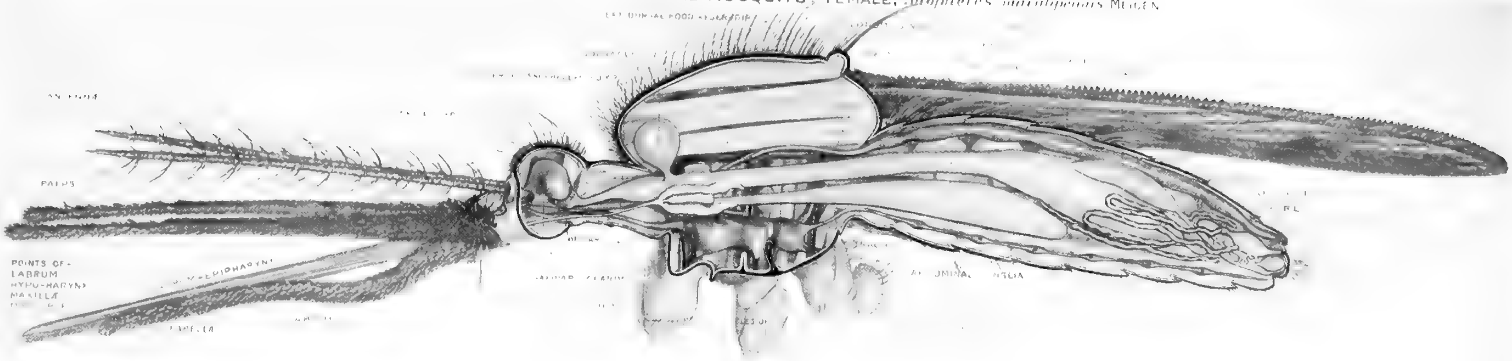
FIG. 25. CHARACTERISTIC POSITIONS OF THE MALARIA AND COMMON MOSQUITO WHEN AT REST.

the surface of the water. In the male, the last abdominal segment terminates in a pair of claspers (Fig. 17).

Color of Adult

The color of the mosquito can be said in general to range from light yellow to dark-brown and almost black. Some species are nearly colorless, or of a very transparent light green. The Malaria Mosquito is brown, the color increasing at first with age till the chitin becomes thickened. The thorax is dark brown above, with a light stripe in the middle and one on each side of the back. The sides of the thorax and the coxæ are light. The upper shields of the abdomen are dark brown, the lower ones lighter and more yellowish. The legs are dark brown above, sometimes with a purplish tinge, and are lighter below, with distinctly yellow spots at the knee-joints. The proboscis and palps appear very dark brown or purplish black. The back of the thorax and the entire abdomen, the soft membrane excepted, are covered with long, golden hairs.

THE ANATOMY OF THE MALARIAL MOSQUITO, FEMALE, *Anopheles maculipennis* MEIGEN



31

FIG. 26. ANATOMY OF THE MALARIA MOSQUITO.

The figure represents a median section of a female. The mouthparts, the antennæ, the alimentary tract and the nervous and reproductive systems have been left entire. From a photograph of the left side of the model shown in Figure 24. Magnification 20 diameters.

The Internal Organs.

When the mosquito bites, blood is pumped up into the "sucking-tube" by two pumps (Fig. 18). The first and smaller pump lies just above the junction of the labrum with the head and forms a direct continuation with the tube. The second, larger and more efficient pump, lies further back in the head and is dilated by powerful muscles. In section it is triangular, with collapsed walls. When dilated by the muscles it fills with blood from the smaller pump and from the tube beyond. It is then allowed to collapse by its own elasticity, and the liquid is forced on into the œsophagus. This is in great part in the neck of the insect and gives off just beyond its entrance into the thorax, three food reservoirs, two small ones above, and a third elongated sac below, which reach far into the abdomen (Fig. 26). It is the blood stored in this reservoir, which in its greatly distended state may be seen through the thin pleural membrane, that gives to the mosquito the red color noticeable after a full meal. The stomach is a continuation of the œsophagus and is tubular, narrow in front but dilated into a sac behind. At its posterior end is a valve-like constriction just beyond which there open into the intestine five excretory tubules. After one or two rather sharp curves, the intestine is continued to the terminal end of the body.

Pumps

Food reservoirs

The nervous system of the mosquito (Fig. 26) consists of a chain of connected centers, or nerve ganglia. In the head several pairs of ganglia are fused to form the "brain," which supplies nerves to the eyes, antennæ, palps and mouth-parts. In the thorax, just above the origin of the legs, there is another large mass consisting of three pairs of fused ganglia which send nerves to the legs, wings and balancers. The nervous system is continued in the abdomen as a chain of small ganglia, six in number. In addition to this main nervous system a pair of small sympathetic ganglia lie on each side of the alimentary tube, in the anterior part of the thorax.

Nervous System

The large thorax is almost entirely filled with the great muscles of flight, consisting of two masses at right angles to each other (Fig. 26). Their alternate contractions change the shape of the thorax and indirectly serve to move the wings in flight. The wings are also controlled by smaller special wing-muscles. The muscles which move the abdominal segments during respiration lie for the most

Body Muscles

part directly on the hard chitinous pieces which compose the upper and lower shields of the abdomen.

Respiration

Respiration is carried on by means of a system of air-tubes, or tracheæ, which open to the exterior by two main openings on either side of the thorax, and by eight smaller ones in the soft membrane of the abdomen (Fig. 21). The tracheæ, by repeated branching, ramify throughout the entire body of the mosquito and supply the blood, as well as every organ and tissue, with air. Nearly filling all spaces between the muscles and the organs, are symmetrically arranged masses of a peculiar tissue, the blood-tissue or fat-body, which is especially well supplied with tracheæ.

Circulation

The circulation of the blood of the insect is maintained by the heart, which is a tubular organ lying directly under the upper chitin-shields of the abdomen (Fig. 22). It is continued forward in the thorax as a vessel, the "aorta," through which the blood is pumped to the head. This is the only blood vessel to be found in insects, and the blood circulates with the respiratory movements throughout the body in the interstices between the fat-tissue and the internal organs. Into the blood in the body cavity of the mosquito, the malarial spores which grow in its stomach-wall escape. Through the circulation of the blood the spores then find their way into the salivary or poison glands.

Poison Glands

These important little glands, which supply the irritating poison of the mosquito bite, lie within the anterior part of the thorax just beyond the neck (Fig. 26). The secretion from each three-lobed gland is conducted forward into the head by a fine tube, the salivary duct. In the head the two ducts join and the common duct empties into the salivary pump (Fig. 18). This, in connection with its continuation, the salivary channel in the hypopharynx, forms a practical syringe by which the poisonous saliva is automatically forced out at the point of the proboscis during the act of feeding. It has been thought that the saliva serves to prevent the clotting of the blood in the mosquito's sucking tube, but this, strangely enough, seems doubtful.[1] Its irritating effect is however well known, and it is, furthermore, with this salivary secretion that the malarial spores are injected into the human circulation.

[1] G. F. H. Nuttall and A. E. Shipley. Jour. of Hygiene, London, 1900, p. 195.

Malaria.

It was early observed that "malaria" was apt to be prevalent during damp and rainy seasons, and that it occurred principally in exactly such places as are now known to furnish ideal breeding grounds for the Malaria Mosquito. That new cases of malaria appeared at the time of year when the Malaria Mosquito abounded, was also recorded long before it was suspected that the insect was in any way connected with the malady; and one of the old medical writers, mentions as a characteristic of malarial seasons, that "gnats and flies are apt to be abundant."

Malarial Seasons

Asia is considered to have been the original home of malaria and from there it was introduced into Europe. In the fourth century B. C. it had become established in Greece, and since this time it has been endemic in Europe, particularly in the countries bordering on the Mediterranean. Its prevalence in Italy and Greece is historic. It is thought to have been an important factor in the decline of the nations of antiquity.[1]

Original Home of Malaria

Malaria was formerly considered to be a form of ague due to foul air, whence its name, which literally means "bad air." It was attributed to a sort of "miasma." Its true nature did not become known till 1880, when Laveran, a French military surgeon, working at the time in Algeria, discovered the malarial parasite in human blood. Some years later, Professor Manson of England, directed the attention of Major Ross of the Indian Service, to the mosquito as a possible carrier of malarial infection. It had at this time just been discovered that yellow fever was spread by mosquitoes, and Manson had previously, in 1879, found a Culex mosquito carrying the parasite of filarial disease. That the insect might play such a direct and extraordinary rôle as it does in the transmission of malaria, was, however, not suspected even by Manson. In 1897 Ross discovered the presence of the malarial organism in a mosquito of the genus *Anopheles,* and a little later, through the efforts, chiefly of Ross and the Italian, Grassi, the remarkable life-history of the parasite became known in its entirety.

Discovery of Malarial Parasite

[1] W. H. S. Jones. Malaria. A neglected factor in the history of Greece and Rome. London, 1907.

As the result of the laborious researches of these scientists, we now know that malaria is not communicated except by the Malaria Mosquito, that this is a member of the genus *Anopheles*, and that consequently, malaria does not exist in any locality in the absence of mosquitoes of this genus. While it is highly probable that all of the forty or more species of the genus, distributed over almost the entire world, may carry malaria, ability to harbor and transmit the malarial parasites has been actually proven of only about half the number. The majority of the species known to be malarial occur in India. The only European or North American member of the genus which stands at present positively convicted of carrying the disease, is the one figured and described in this paper, *Anopheles maculipennis* Meigen. That other mosquitoes, for instance, the common Culex, of which so many species exist everywhere, are as likely as Anopheles to imbibe malarial blood is unquestionable, but in all mosquitoes, except certain Anopheles, the human malarial parasites seem to perish in the alimentary tract of the insect, or the spores are perhaps destroyed by the more acid secretion of the salivary glands.

Malaria and Anopheles

The malarial organisms are unicellular animals, "protozoa," of the class Sporozoa, all members of which are parasitic. The members of the order to which they belong, the *Hæmosporidiida*, are parasitic in the blood of higher animals and resemble the malarial organisms in their life-history. Thus, there is a parasite of "bird malaria" found in pigeons, crows and bluejays, *Halteridium*, transmitted by a Culex mosquito; and another, *Proteosoma*, which lives in the blood of sparrows and is also carried from one bird to another by a mosquito.

When a malaria-infected mosquito bites, the poison or saliva which is injected into the wound carries into the human circulation some minute needle-like or elongated spindle-shaped bodies. These are the malarial spores (Fig. 32, S). Once in the human circulation, each spore, of which there may be half a hundred, enters a red blood corpuscle (Fig. 27, A, B), loses its characteristic form and becomes a minute, rounded, amœboid parasite. After its entrance, this measures one fifth to one fourth of the diameter of the blood cell; but, nourished by the contents of the corpuscle, it grows rapidly (Fig. 27, C, D). The blood corpuscle in which it lives, loses its circular outline, becomes enlarged, and, in a short time, is nearly filled by the growing parasite (Fig. 27, E). At the same time the nucleus of

The Malarial Spores in the Blood

the malarial amœbule divides, till six to sixteen daughter nuclei may be seen (Fig. 27, E). By the time this nuclear division is complete, almost the entire original contents of the red corpuscle have disappeared, little remaining of it but the thin cell-membrane, filled with the enlarged parasitic mass. At last the wall of the corpuscle bursts, and the parasite is liberated (Fig. 27, H). Its protoplasm has by this time divided into as many parts as there are nuclei, and each resulting part forms a new spore, which in its turn, enters a red blood corpuscle (Fig. 27, A). The same process of growth at the expense of the blood cells is then repeated, and new spores are formed by division, accompanied by the destruction of an

Asexual Multiplication of the Parasites

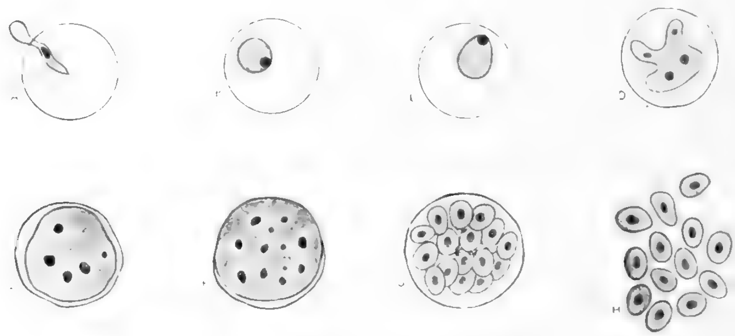


FIG. 27. THE MALARIAL PARASITE. (TERTIAN.) ASEXUAL CYCLE IN THE HUMAN BLOOD

A. Malarial spore entering a blood corpuscle (schematic). B. C. Malarial parasite in the blood corpuscle. D. Enlarged, amœboid parasite. E. Growth and division of the parasite. H. The malarial blood-spores liberated by the bursting of the blood corpuscle. Magnification 1600 diameters. After Ruge.

ever increasing number of red blood cells. This process of multiplication, which constitutes the asexual cycle in the life of the malarial parasite, may go on for a considerable period, till the blood is filled with billions of minute organisms. In time, however, certain of the spores, after entering fresh corpuscles, do not divide, but they develop into forms of the parasite which, if taken up by a Malaria Mosquito, will conjugate and reproduce sexually (Fig. 28).

These new forms, which are approximately spherical in shape, are of two kinds (Fig. 29, A): larger (A) female (egg) cells, and somewhat smaller (A 2), male cells. The latter give rise to long filamentous sperms

when removed from the human circulation. In the mosquito's stomach these sperms fertilize the female cells, a single sperm uniting with each (Fig. 29, B), and as many as five hundred of these fertilized egg cells have been found in the stomach of a single mosquito. The fertilized egg-cell becomes elongated and pointed at one end (Fig. 29, C), and finally works its way into the stomach-wall of the insect (Fig. 30), where the embryo-cells grow and, in fifteen to twenty days, produce large cysts (Fig. 32, C) each of which is filled with thousands of new needle-shaped spores. These cysts, which are on the outer wall of the stomach (Fig. 31), ultimately burst and the hosts of contained spores (Fig. 32, C, S) are set free in the body cavity and, consequently, in the blood of the mosquito. Some of them find their way into the salivary glands (Fig. 32, G) and then into the salivary ducts, whence, at the insect's next meal, they are again injected with the saliva into the blood of another human individual. In this manner malarial infection is handed on from subject to subject.

Sexual forms of the Parasite

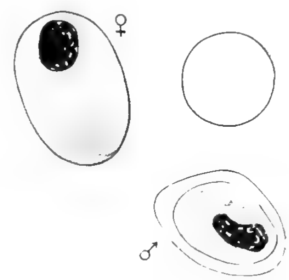


FIG. 28. NORMAL BLOOD CORPUSCLE AND MALE (♂) AND FEMALE (♀) REPRODUCTIVE FORMS OF THE MALARIAL ORGANISM.

Magnification 1600 diameters, after Ruge.

Malarial infection by the "Mosquito bite"

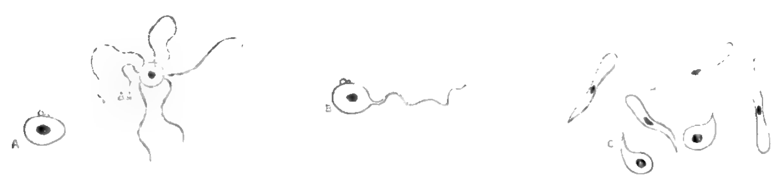


FIG. 29. THE REPRODUCTIVE FORMS OF THE MALARIAL ORGANISM IN THE MOSQUITO'S STOMACH.

(After Schaudinn and R. Koch.)

A. Female, or egg cell. A 2. Male cell giving off sperms. B. Fertilization of the egg-cell. C. The fertilized egg-cell. Magnification 375 diameters.

Forms of Malaria

Three varieties of malaria are distinguished: "tertian," where the fever and chills recur every forty-eight hours; "quartan," where they are separated by an interval of seventy-two hours, and, lastly and most dangerous of all, the irregular

"tropical" malaria, the mild local form of which is known as "æstivo-autumnal." The intervals which separate the paroxysms correspond in length to the duration of the process of spore-formation in the blood cells, the chills marking the liberation of the spores (sporulation). The parasites which produce the three different forms of malaria are considered to be separate species, distinguished chiefly by a difference in the time required for the completion of their cycle of development in the human blood. In this connection it is of interest that immunity against

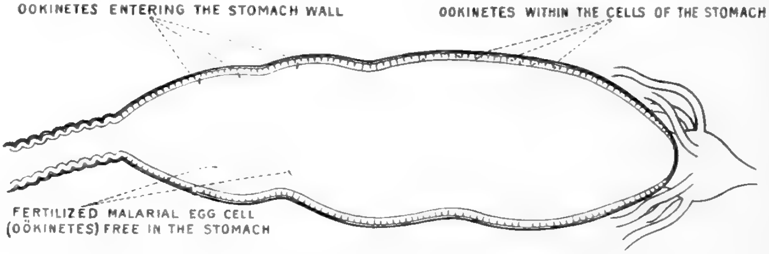


FIG. 30. STOMACH OF THE MALARIA MOSQUITO

Oökinetes are shown entering the stomach wall. Diagrammatic. Magnification about 30 diameters.

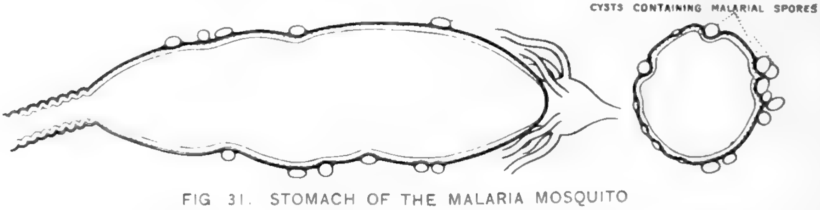


FIG 31. STOMACH OF THE MALARIA MOSQUITO

Malarial "Sporocysts" are shown on the outer wall of the organ. Longitudinal section diagrammatic. Cross section after Grassi. Magnification about 25 diameters.

one form of malarial organism has been found by Professor Koch not to insure immunity against the other two species. The parasite of the tropical variety differs from the others in respect to the appearance of the sexual forms, which are half-moon or crescent-shaped. It was these which were first found by Laveran, and they are termed the "half-moons of Laveran."

With the extermination of the mosquito of a malarial neighborhood the disease will, in time, disappear. Nuttall on the other hand describes districts in England from which malaria has disappeared, although the

mosquitoes remain. This disappearance of malaria may have been brought about by a general use of quinine. Quinine, obtained from various species of trees of the genus *Cinchona*, growing at high altitudes particularly on the Andes and brought into use in Europe in the year 1640 by the Countess Chinchon, vice-queen of Peru, who had been cured of malaria by its use, is the only known specific against malaria. It will, if properly administered, destroy the parasites of tertian and quartan fever in a comparatively short time. The parasite of tropical fever, however, such as exists in its severest form in certain places on the West Coast of Africa, on the southernmost

Effect of quinine

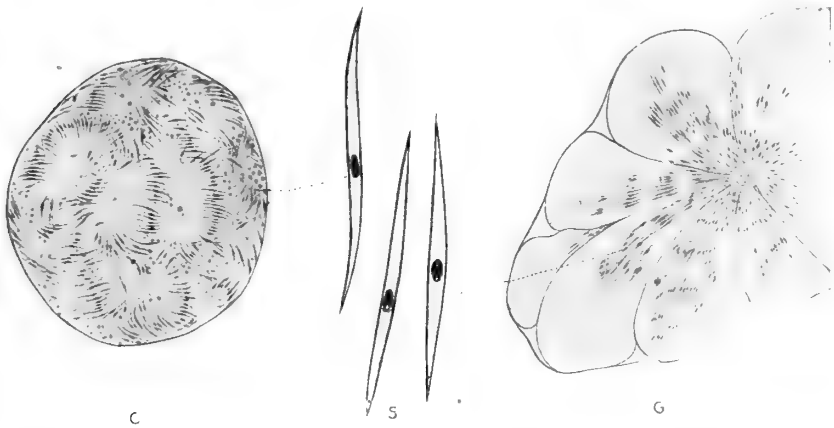


FIG. 32. THE MALARIAL SPORES IN THE MOSQUITO

C. A sporocyst with contained spores (× 400) (after Grassi). S. The liberated spores (× 3000). G. Section of the salivary gland of the mosquito, malarial spores lying in the cells and in the duct of the gland. (× 350) (after Grassi).

of the Philippine Islands and in the Malay Archipelago, is only slightly affected even by quinine, after the parasite has once begun to multiply in the blood. The sexual forms of the malarial organism are especially resistant and may, long after the destruction of all asexual parasites, take the place of these latter and by simple division give rise to new crops of spores. As a preventive the drug has, however, been found highly serviceable by those obliged to travel or to live in tropical malarial countries.

As an example of a local malarial epidemic may be mentioned an outbreak, described by Dr. W. N. Berkeley, which took place near Jerome

Park in the Borough of the Bronx, New York City, in 1900. A search revealed specimens of *Anopheles maculipennis* in every house and generally in the sleeping quarters wherever the disease occurred. In tropical climates, the natives, who often live in dark and poorly ventilated houses, are the chief sufferers, and we learn that, in India and Africa, from 20 to 100 per cent of the children of the native villages, are affected by malaria.[1] In the southern States of our own country malaria is a severe scourge among the negroes, and probably for the same reasons as in India.

Prevalence of Malaria

The Malaria Mosquito seldom rises even to the second story of a house, and it is a well known fact, that persons whose sleeping quarters are high above the ground are seldom attacked by the disease. Since the mosquito is a poor flyer and does not readily rise high above the ground, and since it avoids an abundance of light, its absence from the upper stories of a building is easily understood.

In general, high altitudes insure a freedom from the Malaria Mosquito and from malaria, but there are some notable exceptions, and malaria has been recorded as endemic in certain regions in India where the elevation is four to five thousand feet above sea-level.

Yellow Fever.

The rôle which mosquitoes play in the dissemination of yellow fever was discovered in 1881 by Dr. Finlay of Havana, and communicated by him in papers on the "Natural History of Yellow Fever" (1881–1886). A suspicion that some insects were concerned in the spreading of the disease had been expressed as early as 1848 by Nott, a physician of Mobile, Ala. Not much credence, however, was given to Finlay's discovery till it had been firmly established that malaria was transmitted by mosquitoes; and the real experimental proof of transmission by the mosquito was furnished by a commission of United States Army surgeons which was sent to Cuba by former Surgeon-General Sternberg for the purpose of carrying on investigations. The findings of the commission, which was in charge of Major Reed, U. S. A., positively demonstrated that yellow fever was communicated by the bite of a "Yellow Fever Mosquito" (*Stegomyia fasciata*

Mosquitoes and Yellow Fever

[1] Stephens and Christopher in Reports to the Malaria Committee of the Royal Society. Sixth series, March, 1902, p. 2, and elsewhere.

Fabricius) which must previously have fed on the blood of a yellow fever patient; that the fever could not possibly spread without the presence of a mosquito, and that simple contact with a yellow fever patient was not dangerous. To assure themselves of the correctness of their conclusions, members of the commission in the course of their investigations even went so far as to sleep for weeks in bed clothing soiled by yellow fever patients.

The organism which causes the yellow fever, has not, up to the present time, been found; but it is in every way probable that it will prove to be a

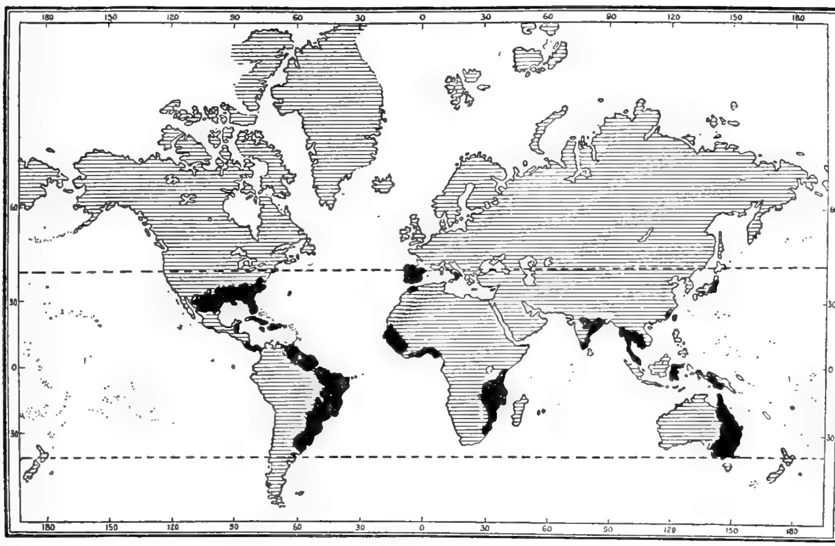


FIG. 33. THE DISTRIBUTION OF STEGOMYIA.
After Theobald.

blood parasite of the class Sporozoa, its life-history resembling in a general way that of the malarial organism. The period of incubation in man, *i. e.*, the period which must elapse between the bite of the infected mosquito and the beginning of the sickness, varies from forty-one hours to not more than six days. The period of its development in the mosquito was found by the commission to be twelve days or more. This fact is of very great importance in relation to quarantine measures, and makes it entirely possible to prevent the introduction of yellow fever into any port where it does not exist.

Period of Incubation

At the same time, the briefness of the period of incubation insures a practical freedom from yellow fever to places where the Yellow Fever Mosquito occurs, if they be distant but six days from an infected port. Hawaii is at present an example of such freedom from the disease, although the Stegomyia occurs there.

The Yellow Fever Mosquito is essentially tropical and sub-tropical. On the American continent its chief habitat is Central and South America

FIG. 34. THE YELLOW FEVER MOSQUITO (*Stegomyia fasciata* Fabricius)

1 and 2 females. 3 male. The figure shows well the banded abdomen, the markings on the thorax and the striped legs. (Magnification about 5 diameters.) From E. A. Goeldi: Os Mosquitos no Pará, 1905.

and the West Indian Islands. It is, however, found in the Southern States, as may be seen on the map, Fig. 33. According to Dr. Howard its life zone, over which it might well spread, includes practically all of the Southern States, as far north as Mason and Dixon's Line. Theobald, of the British Museum, puts its distribution between 48 degrees north and south latitude. That it may be carried

Distribution

far northward and under favorable conditions live, and perhaps breed, is shown by records of yellow fever epidemics in New York and Philadelphia in the early part of the past century. The success of the sanitary work done in Cuba under General Wood bears abundant witness to the effectiveness of measures for the extermination of Stegomyia mosquitoes, and of proper isolation of yellow fever patients from the insect by the simple means of mosquito netting.

The Yellow Fever Mosquito

The Yellow Fever Mosquito is known as a "day mosquito," and was formerly considered a species of Culex. The back of the thorax is marked by silvery stripes, the dark-brown or black sides of both thorax and abdomen are ornamented with conspicuous white spots, and each segment of the abdomen bears a white cross-stripe. The knee-spots of the black legs are white, and the tarsal joints are banded with white. These markings make the mosquito quite easy to recognize.

Insects as Carriers of Disease.

The whole question of the relation of insects to disease is a subject not only of significance to the medical world and of great interest to the naturalist, affording as it does a striking and most recent instance of the relation of medical science to natural history, but it has also become a matter of general and urgent sanitary importance, and as such demands an enlightened public appreciation.

Filarial disease

Many kinds of insects have been found to be instrumental in the spreading of disease, either by simply conveying disease germs from one place to another, or by actually harboring germs of parasites, which grow and multiply in the body of the insect till they are transferred by its bite to another animal or a human individual. This latter is the case not only in malaria and yellow fever, but also in many of the other most-dreaded diseases of man and beast, in which an insect has been found to serve as the intermediary host for a disease-producing organism. Our first knowledge of an instance of this kind was gained by the discovery in the proboscis of a species of a Culex mosquito by Professor Manson in India (1879) of the minute parasitic worm which produces the terrible filarial disease, or elephantiasis.[1] Since the time of Manson's discovery new instances of this

[1] The filarian worms find lodgment in the lymphatic vessels and by blocking the natural flow of the lymph at certain points cause enormous enlargement of parts of the body.

nature have continually come to light. The most notable recent example is, perhaps, the African "sleeping sickness," caused by a protozoan blood parasite, *Trypanosoma*, of which many species causing severe, usually fatal affections have been found in the circulation not only of man and the domestic animals, but also of reptiles and fishes. The insect which serves as the intermediary host is the notorious "tsetse-fly." The fatal "tsetse-fly disease" and the "kalaazar" or "black water fever" are two stock diseases due to this organism. Cattle and horses used for travel are killed by them in a few days. The devastation due to these diseases has been so great that certain districts in South Africa have had to be abandoned by the inhabitants. A constant supply of the parasites is obtained by the flies from numerous wild animals which have in the course of time become immune to the disease. It has been suggested that the extinction of, for example, the horse on the American continent might probably have been due to the destructive agency of some disease-bearing insect.[1] The discovery at Florissant, Colorado (T. D. Cockerell, 1907), of a fossil tsetse-fly would seem to bear out this hypothesis.

Sleeping Sickness

Texas Fever

The well-known "Texas fever" or "red water fever" which has been introduced into many parts of the world and which has occasioned enormous losses to the cattle-breeders of the southwestern part of the United States is another example of a disease that has been conveyed by an insect, and caused by another type of protozoon, *Piroplasma*, parasitic in the blood. The insect in this case is the cattle tick (*Margaropus annulatus* Say). The list is growing, and the investigations which are now being carried on, particularly by the German and English Governments, may prove to be productive of important results.

The Bubonic Plague

English investigations in India and China have just brought to light the mode of transmission of the bacterial bubonic plague. It has been found that a minute flea, which normally lives on gray rats, carries the disease. When the rats die from the plague by thousands, the fleas find human victims and thus epidemics are produced.

In connection with the subject of insects as carriers of disease, the ordinary house fly should not be forgotten, since it disseminates tuber-

[1] H. F. Osborn: The Causes of Extinction of Mammalia. The American Naturalist. Dec. 1906.

culosis, cholera and typhoid fever. The house-fly breeds in decaying matter, and its habits are so filthy, that even if for no other than esthetic reasons, it should be the first object of the general war on pestiferous insects, begun long ago by the agriculturists for economic reasons, but now become also a problem of sanitary importance for which communities and governments will be compelled to spend great sums of money.

The House-fly

Mosquito Extermination.

The study of disease-producing parasites and of the insects concerned in their transmission is not only indicating rational procedures for the extermination of the latter, but also, as in the case of yellow fever, furnishing a scientific basis for such quarantine and preventive measures as are at present carried out by the United States Government in Panama, and to some extent by modern nations everywhere. The far-reaching effect of such discoveries as those described above is difficult to estimate. The stimulus which they have given to research has already proved to be of vast moment. The practical results in tropical countries and colonizing nations will grow, as distant and hitherto almost uninhabitable parts of the world are opened up. In our own immediate neighborhood they have led to a campaign of extermination against the Malaria Mosquito, and indirectly have served to call public attention to the whole tribe of these insects, which, even though they may not all spread human diseases, nevertheless constitute a pernicious pest which renders large areas unfit for habitation. When we consider that within a radius of twenty-five miles of New York there exist two hundred square miles of marsh and swamp land,[1] the local mosquito problem alone will be seen to be far from insignificant. Such a campaign of extermination of mosquitoes as is now being waged in the State of New Jersey under the supervision of Professor Smith would have been considered before the time of the discoveries of Ross and Finlay, not only extravagant, but really insane.

Preventive and Quarantine Measures

The local Problem

When the problem of mosquito extermination on a large scale, first presented itself, it became, of course, necessary to devise effective means

[1] Felt: Mosquitoes of New York State, New York State Museum Bulletin 79, p. 244, 1901.

for its accomplishment. In the light of some knowledge of the habits and life-history of the mosquito, there was no difficulty in discovering that any extensive attempt to cope with the insects must be directed toward its destruction in the aquatic larval and pupal stages. A consideration of the "natural enemies" of the mosquito, which might be taken advantage of for the purpose, would seem to bear out such a decision, for in the case of the adult mosquito, these are practically confined to a few insectivorous birds which fly at dark, while the animals which prey on the larvæ are very numerous.

Practical Methods of Extermination

The systematic investigations of the subject, which have covered the ground very fully, make clear the practical measures that must be used, and the actual work which has been accomplished leaves no more room for any doubt that in civilized communities, mosquitoes may be, if not exterminated, at least reduced in number to a minimum. Professor Howard in his book, "Mosquitoes, How they live, etc.", (1901) gives an account of the work done at his instigation by the national and various local governments, up to that time. The "Report on Mosquitoes" (1905) of the New Jersey Agriculture Experiment Station, contains an account of Professor Smith's extensive investigations, which are put to the most practical use.

Natural Enemies of the Mosquito

Professor Smith finds that the larvæ are eaten by certain shore birds, like sand-pipers, and by other insects and their larvæ, such as the whirligig beetles (*Gyrinidæ*), water-scorpions (*Ranatra fusca*), and especially the larvæ of a diving beetle (*Dytiscus*), one of which was observed in confinement, to kill and eat 434 wrigglers in two days. Tadpoles are found to be practically worthless for the purpose. The most active enemies of the larvæ are small fishes of various kinds, such as minnows, "sunfish," the common "killifish" or "saltwater minnow," the "sheep-head minnow" and the "top minnow." One or more varieties of these or other small fishes, if introduced wherever there is a permanent body of water, will effectually keep mosquito larvæ from hatching. The fish must be carefully selected with reference to their preference in respect to environment, of which an account is to be found in the report mentioned above. The complete absence of larvæ in many places where they would naturally be expected, like cat-tail swamps, may undoubtedly be accounted for by the presence of some species of small fish.

Mosquitoes do not live in running water, and as a matter of fact, the greater number by far, hatch in places where fish could not possibly be maintained, hence other measures for extermination must be resorted to. The use of crude petroleum spread as a thin film on the surface has long been known to kill the larvæ and pupæ, but it is applicable only to small bodies of water, and it is not lasting in its effect. Poisoning of the water must naturally be restricted in its application, but it is effective, and of the agents tried, "phinotas oil" which is highly diffusible, is found to give much the best results. Cisterns, rain barrels and other receptacles in which mosquitoes are apt to breed in large numbers and in which poisoning of the water is not permissible, should be kept covered, while other mosquito-breeding collections of water in which fish cannot be used, should be treated by drainage or filling.

The Use of Oil

The saltwater marshes of New Jersey, which give rise to billions of insects that spread inland, are at present being drained by machine-dug ditches, and at comparatively small cost per square mile. In many cases, the simple introduction of tide-water into the low-lying shore districts, will bring about sufficient movement of the shallow stagnant water of the marshes to reduce greatly the numbers of mosquitoes that hatch.

Drainage

LITERATURE ON MOSQUITOES.

An old work "Micrographia Curiosa" by P. P. Bonnani, published in 1691, contains what is perhaps the first account of the mosquito and its life-history. A "Dissertation de Culice" by Johann Mathews Barth, dates from 1737; the "Bybel der Natuure" (1738) by the Dutch naturalist Swammerdam who evidently was not acquainted with any previous accounts of the mosquito, contains an excellent description of its metamorphoses, illustrated by plates, which surpass many of the illustrations of the insect published in more recent years. After the time of Linnæus the literature, of course, becomes more extensive, but no especially great attention was paid to the family Culicidæ till after the discovery of its disease-carrying propensities. The number of works dealing with the insects from a natural history point of view, is somewhat restricted, but papers treating of the medical aspects of the subject are exceedingly numerous.

Below are enumerated a few of the most important and easily accessible works on mosquitoes and on the subject of insects as carriers of disease. To

all of these, as well as to many others, the writer is indebted for much of the information contained in this paper.

BERKELEY, W. N. Laboratory work with Mosquitoes. New York, 1902. A brief guide, introductory to microscopic work, particularly with salivary glands and the malarial organism.

CHRISTOPHERS, S. R., and STEPHENS, J. W. W. Reports to the Malaria Committee, Royal Society. London, 1900–1903. Brief Reports on Mosquitoes, in relation to Malaria in India, and the East Coast of Africa, also, a short description of the anatomy of the mosquito.

BLANCHARD, R. Les Moustiques. Histoire Naturelle et Médicale. 673 pp. Paris 1905. A comprehensive systematic work.

HOWARD, L. O. Mosquitoes. How they live, How they carry disease, How they are classified, How they may be destroyed. 241 pp. New York, 1901. An excellent popular account.

GILES, GEORGE M. A Handbook of the Gnats or Mosquitoes. Giving the Anatomy and Life-history of the *Culicidæ*, together with descriptions noted up to the present date. 530 pp. 1902.

NUTTALL, G. H. F. On the Rôle of Insects, Arachnids and Myriapods in the spread of Bacterial and Parasitic Diseases of Man and Animals. A critical and historical study. Johns Hopkins Hospital Reports, Vol. VIII, 154 pp. Baltimore, 1899–1900.

NUTTALL, G. H. F., and SHIPLEY, A. E. The Structure and Biology of Anopheles. The Journal of Hygiene, Cambridge and London. Vol. I. 1900.

Contains the results of their admirable and very complete technical study of the structure and biology of the malaria mosquito.

SMITH, JOHN B. Report of the New Jersey State Agricultural Experiment Station, upon the Mosquitoes occurring within the State, their Habits, Life-History, etc. Trenton, 1905.

A comprehensive and interesting report of Professor Smith's thorough investigation, from a practical as well as purely scientific point of view, of the natural history of the mosquito, and the methods which should be used in its extermination.

RUGE, REINHOLD. Einführung in das Studium der Malaria Krankheiten mit besonderer Berücksichtigung der Technic. 2te Auflage, Jena, 1906.

An excellent, clear exposition of scientific knowledge of malarial parasites and the clinical aspects of malaria, well illustrated.

THEOBALD, FRED V. A monograph of the Culicidæ or Mosquitoes of the World, mainly compiled from the collections received at the British Museum from various parts of the world, in connection with the investigation into the cause of malaria, conducted by the Colonial Office and the Royal Society. 4 Vols. London, 1903.

The only comprehensive and thorough, systematic account of the mosquitoes of the world.

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price, 10 cents.*

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. October, 1903. *Price, 10 cents.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRD'S NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted,* February, 1905. *Price, 10 cents.*

No. 15.— PRIMITIVE ART. July, 1904. *Price, 15 cents.*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price, 15 cents.*

(*Reprinted from The American Museum Journal.*)

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS, AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1905. *Price, 15 cents.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Price, 15 cents.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price, 15 cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Price, 10 cents.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price, 15 cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Price, 10 cents.*

(*Published as a separate series.*)

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price, 10 cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. Price, 15 *cents.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D. Associate Curator of Geology. December, 1907. *Price 10 cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Price, 15 cents.*

The American Museum Journal

Edmund Otis Hovey, *Editor.*

Frank M. Chapman,
Louis P. Gratacap,
William K. Gregory, } *Advisory Board.*

Subscription, One Dollar per year. Fifteen Cents per copy.

A subscription to the Journal is included in the membership fees of all classes of Members of the Museum.

Guide Leaflets Published by the

AMERICAN MUSEUM OF NATURAL HISTORY

For Sale at the Museum.

(Issued as supplements to The American Museum Journal)

No. 1.— THE BIRD ROCK GROUP. By F. M. Chapman, Associate Curator of Mammalogy and Ornithology. Oct., 1901. 10 *cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. Smith, Assistant Curator of Archæology. Dec., 1901. 10 *cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. Matthew, Ph. D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By Louis P. Gratacap, A. M., Curator of Mineralogy. February, 1902. *Revised edition,* May, 1904. *Price,* 10 *cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. Allen, Ph. D. Curator of Mammalogy and Ornithology. March, 1902 *Revised edition,* February, 1904. *Price,* 10 *cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By George H. Pepper, Assistant in Anthropology. April, 1902. *Price,* 10 *cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By William Beutenmüller, Curator of Entomology. May, 1902. *Price,* 15 *cents.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By George H. Sherwood, A. M., Assistant Curator. November, 1902. *Price,* 10 *cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. Matthew, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition,* May, 1905. *Price,* 10 *cents.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By William Beutenmüller, Curator of Entomology. February, 1903. *Price,* 10 *cents.*

(Continued on page 3 of cover.)

AMERICAN MUSEUM OF NATURAL HISTORY

THE HABITAT GROUPS OF NORTH AMERICAN BIRDS

By FRANK M. CHAPMAN

CURATOR OF ORNITHOLOGY

GUIDE LEAFLET No. 28 THIRD EDITION

FLAMINGOES AND YOUNG

One of many studies made by Dr. Chapman for the Flamingo Group

THE HABITAT GROUPS

OF

NORTH AMERICAN BIRDS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

BY FRANK M. CHAPMAN

CURATOR OF ORNITHOLOGY

GUIDE LEAFLET SERIES No. 28

PUBLISHED BY THE MUSEUM

NEW YORK, JANUARY, 1921

THIRD EDITION, REVISED AND ENLARGED

Camp at Ptarmigan Pass, Canadian Rockies

THE HABITAT GROUPS OF NORTH AMERICAN BIRDS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By Frank M. Chapman

Curator of Ornithology

THESE groups of birds are designed to illustrate not only the habits but also the haunts or "habitats" of the species shown. Each group usually includes the nest, eggs and young, besides the adult bird or birds, with a reproduction of from 60 to 160 square feet of the nest's immediate surroundings. To this accurate and realistic representation of the home of the species is added a painting from nature of its habitat, the real foreground being connected with the painted background in such a manner that often one does not see where the former ends and the latter begins. The whole, therefore, gives an adequate conception of the nature of the country the birds inhabit and the conditions under which they live.

It should be clearly understood that these backgrounds are not more or less fanciful sketches of the haunts of the birds associated with them, but they are careful studies from nature of definite localities, and therefore possess a geographical as well as an ornithological value. When selecting subjects for treatment, an effort was made to include the birds of widely diversified types of country, in order that the series, as a whole, should portray not only the habitats of certain American birds, but America as well. From the Bahamas to Hudson Bay, from the Atlantic to the Pacific, localities are represented which show at least the more characteristic phases of our landscape, and it is hoped that a tour through this hall of Habitat Groups will not only yield information in regard to North American birds, but also give one some conception of the appearance of the land in which they live.

Some subjects were in nearby places and were easily visited; others were in remote regions and were reached with more or less difficulty.[1] It is estimated that about 75,000 miles have been traveled to secure the material on which the groups are based.

[1]The narrative of many of these expeditions is contained in "Camps and Cruises of an Ornithologist," by Frank M. Chapman

Each group in the series, beginning with Bird Rock in the Gulf of St. Lawrence, in 1898, is the result of a special Museum expedition in charge of the Curator of Ornithology, usually accompanied by a preparator, and one of the artists whose names appear in connection with the backgrounds they have painted.

After arriving, before securing specimens, the birds were first studied and photographed at short range from an especially constructed umbrella-blind. This was sometimes placed in the very heart of the bird community, as, for instance, with the Flamingoes and Pelicans; or even in the tree-tops as with the Egrets. At the same time the artist made studies on which to base the final background, as well as detailed color sketches of leaf and blossom, while the preparator collected the needed accessories, making casts or preserving vegetation in various solutions as occasion required. When the field-work was concluded, the crates of branches, carefully packed boxes of foliage, nests, birds and photographic plates, sacks of earth and other material, according to the nature of the subject, were shipped to the Museum, subsequently to be prepared in the laboratories.

The vegetation, by Mr. J. D. Figgins, Mr. A. E. Butler and other members of the Department of Preparation, has been reproduced in wax, either from plaster molds of the original, or by careful duplication of the original itself. The color has been applied with an air-brush or atomizer, by which the most delicate tints and textures are faithfully rendered.

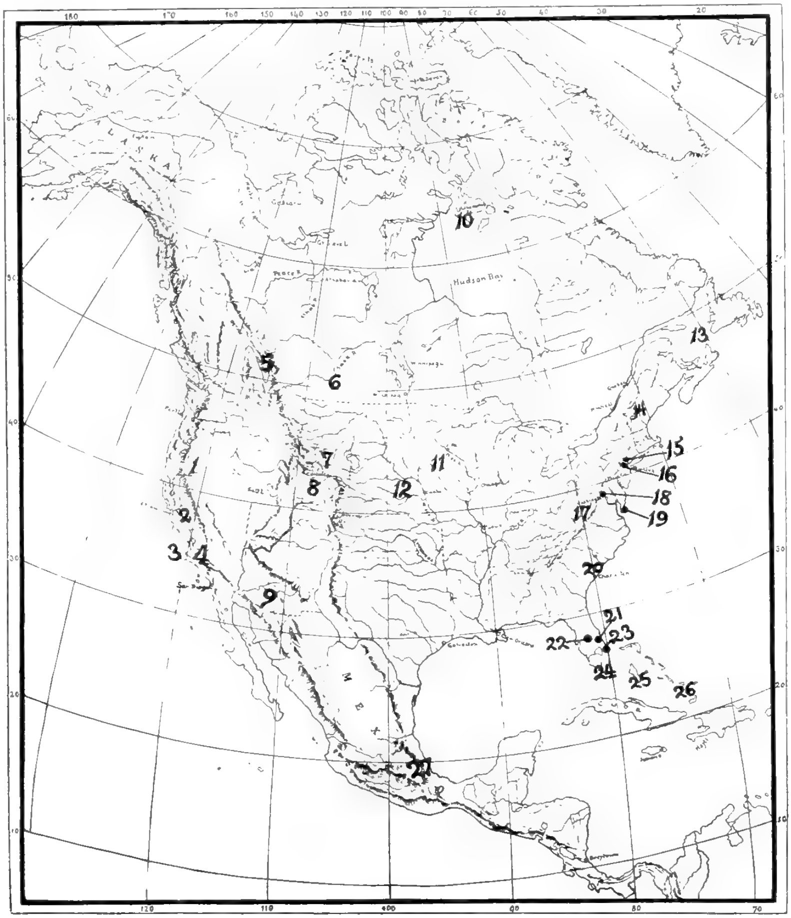
Each group has demanded its own special treatment, and, in the construction of the series, the many novel problems encountered have resulted in the development of original methods. This is particularly true of the manner of installation and illumination of the groups at the sides of the hall. Here, it will be observed, the background is curved, with the front opening so reduced in size that at the proper distance, or "correct viewpoint," neither the ends nor the top of the group can be seen. By thus leaving the actual limits of the group to the imagination, the illusion of space and distance is greatly heightened.

The groups are illuminated from above by diffused light; electric light being employed when daylight fails, but, in either case, the rays strike the group from the same diffusing surface.

The Museum owes this series of Bird Groups primarily to the generosity of a number of its members, without whose contributions the collection and preparation of the material would not have been undertaken.

For this valuable coöperation the Museum is indebted chiefly to Mr. John L. Cadwalader and to Mrs. Morris K. Jesup, Mrs. Philip

Schuyler, Mrs. John B. Trevor, Mrs. Robert Winthrop, Mr. F. Augustus Schermerhorn, Mr. H. B. Hollins, Mr. Henry Clay Pierce, Mr. Henry W. Poor, Mr. Courtenay Brandreth, and Mr. James C. Carter.

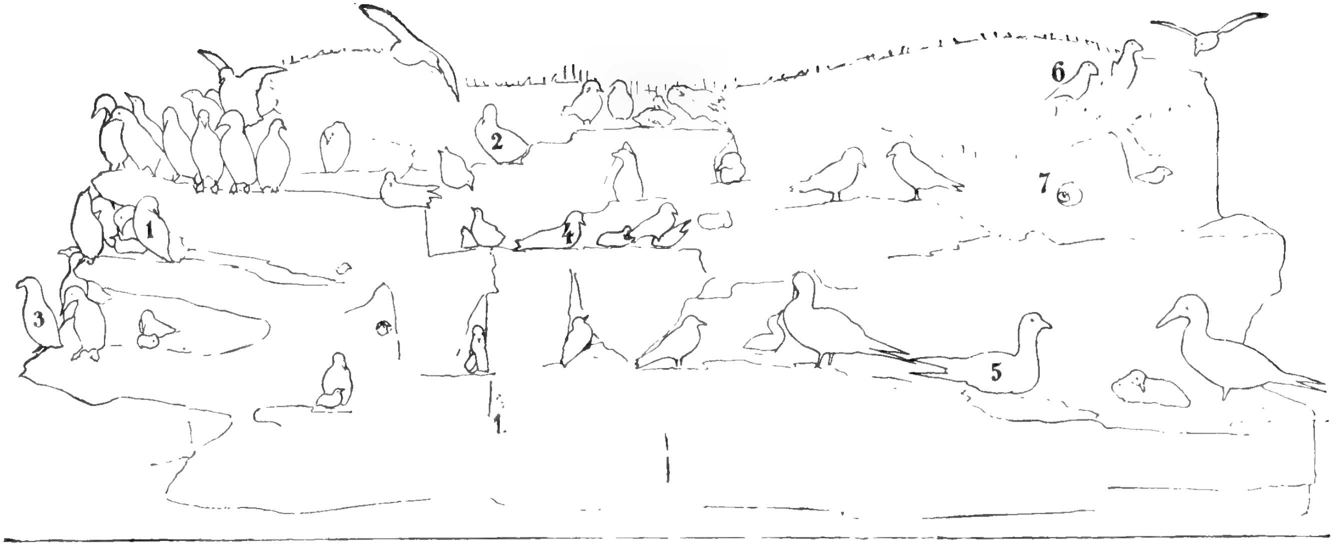


Map indicating localities represented by the groups

1. Klamath Lake, Oregon-California boundary
2. San Joaquin Valley, California
3. Brandt's Cormorant, Monterey, California
4. California Condor, Piru Cañon, California
5. Ptarmigan Lakes, Alberta
6. Canada Goose and Grebes (two groups), Crane Lake, Saskatchewan
7. Golden Eagle, Bates's Hole, Wyoming
8. Sage Grouse, Medicine Bow, Wyoming
9. Cactus Desert, Tucson, Arizona
10. Whistling Swan, Southampton Island, Hudson Bay
11. Whooping Crane, Heron Lake, Minnesota
12. Prairie Hen, Halsey, Nebraska
13. Bird Rock, Magdalen Islands, Gulf of St. Lawrence
14. Loon, Lake Umbagog, New Hampshire-Maine boundary
15. Duck Hawk, Palisades at Englewood, N. J.
16. Hackensack Meadows, N. J.
17. Wild Turkey, mountains of West Virginia
18. Turkey Vulture, Plummer's Island, near Washington, D. C.
19. Cobb's Island, Virginia
20. American Egret, near Charleston, South Carolina
21. Brown Pelican, Indian River, Florida
22. Sandhill Crane, Kissimmee Prairies, Florida
23. Anhinga and Ward's Heron (two groups), near St. Lucie, Florida
24. Cuthbert Rookery, Florida
25. Flamingo, Bahamas
26. Booby and Man-o'-war Bird, Cay Verde, Bahamas
27. Mount Orizaba, Vera Cruz, Mexico

Bird Rock

The First of the Habitat Bird Groups in the American Museum



Key to the Bird Rock Group

1, Common Murre. 2, Brünnich's Murre. 3, Razor-billed Auk. 4, Kittiwake Gull. 5, Gannet. 6, Puffin. 7, Leach's Petrel.

THE BIRD ROCK GROUP

A Study of an Island Colony

To the preserving influence of island-life we owe the continued existence of many birds that have long ceased to live, or, at least, to nest, on the mainland. In every instance, however, whether the island be a thousand square miles or one square foot (as a Grebe's floating nest) in extent, it owes the preservation of its bird-life to the same cause—the entire or comparative absence of bird enemies, terrestrial mammals in particular.

Bird Rock, with its neighbor, Little Bird Rock, belongs to the Magdalen Group in the Gulf of St. Lawrence. It is 351 yards long, from 50 to 140 yards wide, and rises abruptly from the sea to a height of from 80 to 140 feet. Its vertical rocky walls are weathered into innumerable ridges, shelves and crevices—fit sites for the nests of the sea-birds that for centuries have made the Rock their home. The birds, furthermore, have found an abundance of food (chiefly fish), in the surrounding waters.

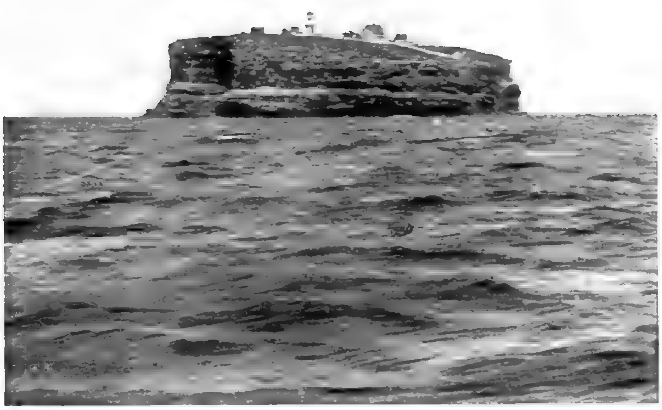
The Bird Rock Group was not definitely planned as a "habitat group," but rather as a picture of part of a famous and impressive bird colony and a permanent record of a characteristic phase of island-life.

The material for the group was collected in July, 1898, and for many years the group marked the highest point reached in the presentation of bird-life. It includes examples of the various species that breed—one can hardly say nest—on the rock, the most noteworthy and noticeable being the great white Gannets. Then come the Murres, Razorbills and Puffins, the graceful Kittiwake, and, last and least, Leach's Petrel, seldom seen because it nests in little burrows like rat-holes and comes and goes at night.

The Bird Rocks are of interest alike to naturalist and historian, for their story begins with the discovery of these little islets by Jacques Cartier in June, 1534. He records his visit as follows: "These islands were as full of birds as any meadow is of grass, which there do make their nests, and in the greatest of them there was a great and infinite number of that that we called Margaulx that are white and bigger than any geese, which were severed in one part. In the other were only Godetz and Great Apponatz, like to those of that island that we above have mentioned. We went down to the lowest part of the least islands, where we killed above a thousand of those Godetz and Apponatz. We put into our boats as many as we pleased, for in less than an hour we might have filled thirty such boats of them. We named them the islands of the Margaulx."

Three centuries later, Audubon, whose energy in exploration no ornithologist has ever surpassed, visited this colony and was duly impressed with its wonders, though the freshening wind prevented him from landing on the rock itself.

Then evil days fell upon this bird metropolis; fishermen commenced to visit it to obtain birds and eggs for food and birds for bait; a lighthouse was erected and, within ten years, the Gannet population of 100,000, which, seen from a distance, had caused Audubon to think that this rock was covered with snow, was swept from the top of the rock. To-day, though still one of the ornithological wonders of our Atlantic coast, the colony is but a shadow of its former self. Fortunately, in March, 1919, the Rock was made a bird sanctuary by the Canadian Parliament and under protection its population should increase.



Bird Rock from the Southwest

Distance about one-half mile

(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

The Orizaba Group

The observer is looking across the valley of the Rio Blanca, over the tropical forest, to Mount Orizaba

Background by Bruce Horsfall. Birds by Harry Raven and Walter Escherich.

THE ORIZABA GROUP

A Study of the Influence of Altitude on the Distribution of Life

FROM the dense tropical forests, at the base of Mount Orizaba in Vera Cruz, Mexico, one may look upward toward the equally grand forests of pines and spruces which, 10,000 feet higher, cover the sides of the mountain.

In the luxuriant vegetation are Parrots, Toucans, Trogons, Motmots, and many other tropical birds; and from their home one may see the zone where Crossbills, Evening Grosbeaks, Juncos, Brown Creepers, and other boreal birds are nesting. Owing to differences in altitude, which are the equivalent of differences in latitude, the three great Life Zones which go to make up the faunal regions of North America are thus represented in this one group, which may be said to epitomize all the other groups contained in this hall.

The studies for this view of Mount Orizaba were made at Cordova (altitude 3,500 feet), at the upper border of the Tropical Zone. The primeval tropical forest having long since been cut off in this region, it was necessary to descend to a level of about 1,000 feet, near Motzorongo, to secure studies for the forest depicted. The accompanying view of the Rio Blanca was also made near this point, from which Mount Orizaba may be seen in the same relation in which it is here painted.

The birds contained in this group are representative species of the tropical portions of the State of Vera Cruz. They have been selected to show the tropical character of the bird-life of this region, rather than the bird-life of any particular part of it; and represent but a small part of the avifauna of several hundred species.

A Glimpse of Cobb's Island

Background by Walter Cox. Birds by H. C. Denslow.

SUMMER BIRD-LIFE OF COBB'S ISLAND, VIRGINIA

A SHELL-STREWN sand-bar seven miles long and about the same distance from the mainland, Cobb's Island, off eastern Virginia, is an ideal resort for sea-birds. Here they are beyond the reach of most bird enemies, while the surrounding waters furnish an unfailing supply of food. The home of the birds has little or no value as "real estate"; they themselves are unfit for food, and it might have been supposed that their continued existence was assured, but about twenty-five years ago they suddenly acquired a commercial value. Their plumage became fashionable for millinery purposes. As a result, thousands of birds were slaughtered on their nesting-grounds, and within a few seasons some of the most abundant species were practically exterminated.

At no place were more birds killed than on Cobb's Island and the islands immediately adjoining it. In a single day, 1,200 Least Terns were shot on Cobb's Island; in three days three baymen killed 2,800 Terns in the same locality; at the end of two seasons the Least Terns, for which there was especial demand, no longer existed in this region, and the Common Terns were greatly reduced in numbers. Fortunately the State of Virginia passed a law prohibiting the killing of these birds, and for several years the National Association of Audubon Societies provided a warden to enforce this law during the nesting season.

In response to this protection the birds began increasing in numbers, and in time may become as abundant as they formerly were. The Least Terns have not reappeared, there being no stock to begin with, but the Common Terns are yearly becoming more numerous, several hundred pairs having nested on the island even in the summer of 1902.

Besides the Common Terns, Skimmers, Gull-billed Terns, Oyster-catchers and Wilson's Plovers now nest on the beach of Cobb's Island; while in the marshes which flank the beach on the bay, or west side, numerous Laughing Gulls, a few Forster's Terns and many Clapper Rails, or Marsh Hens, make their nests.

The Duck Hawk on the Palisades

Background by Hobart Nichols. Birds by John Rowley.

THE DUCK HAWK ON THE PALISADES

THE Duck Hawk is the American representative of the Old World Peregrine Falcon, from which it differs but slightly in color and not at all in general habits.

By falconers the Peregrine was esteemed only second to the Arctic Gyrfalcons. The latter could be owned and flown only by members of the royal family, while no one of lower rank than an earl was permitted to use a Peregrine.

Possibly the restrictions imposed on the owning of Gyrfalcons arose from the difficulty with which the birds were obtained rather than from their superiority as hunters. In this respect the Peregrine, or Duck Hawk, is probably not excelled by any other bird of prey. Its speed enables it to overhaul with ease the swiftest-flying ducks, while it has sufficient strength to strike and kill them in the air and bear them away without visible effort.

The Duck Hawk is fearless in pursuit of its prey and will dash down and capture a wounded bird within reach of the sportsman's arm; and will repeat the attempt even if fired at and missed.

Peregrines in slightly varying forms are found throughout the greater part of the world. The Duck Hawk, the American form, breeds locally throughout most of the United States, and migrates as far south as Chile. When migrating, it is sometimes not uncommon along our coasts, since it travels with the flocks of wild fowl on which it preys, but when nesting it is generally rare.

In the vicinity of New York City Duck Hawks are known to nest only on the Palisades of the Hudson, where they are unfortunately molested by egg-collectors, and among the hills and mountains to the northward. It is believed that, in the spring of 1908, three pairs were nesting on the Palisades.

In this region Duck Hawks begin to lay in March. They build no nest, but lay their eggs, as may be observed, on the bare rock.

The material for the present group was collected by R. B. Potter on Hook Mountain, near Nyack, N. Y., but it is here shown against a background representing the Palisades, northward from the "Gorge" at Englewood.

August Bird-Life of the Hackensack Meadows

Background by Bruce Horsfall. Birds by Ernest W. Smith.

AUGUST BIRD-LIFE OF THE HACKENSACK MEADOWS

THE thousands of acres of marshland bordering the Hackensack River and Newark Bay, so familiar to travelers over the railways which pass through them, are commonly esteemed worthless ground, but to the naturalist they abound in interest.

In their lower portion, colonies of Florida Gallinules and Pied-billed Grebes have been found nesting; but it is in August that birds are most abundant in the marshes, and they then possess the strongest attraction for the ornithologist. At this season the wild rice begins to ripen, bringing to the marsh a large, though ever decreasing, number of Bobolinks and Sora Rails that delight to feed upon it.

The Bobolink is now in its streaked, sparrow-like plumage, and under the name "Reedbird" is ranked in New Jersey as a game bird (!) and is killed in thousands by men who would not raise a finger against the black-and-buff songster of our June meadows.

The Sora, in spite of its small size and sluggish flight, may, with greater reason, be ranked as a game bird, but at the present rate of decrease it will pay the penalty of this distinction by practical extermination in this region. Red-winged Blackbirds also come to feed on the rice.

During the latter half of July, August and September, Swallows (by far the most abundant birds of the meadows) use the marshes as dormitories, coming to them in incalculable numbers in the evening to sleep, and leaving them early the following morning to radiate to every point of the compass. During the day, and as the birds gather for their evening flight, they may be seen perching in long lines on roadside telegraph lines.

In August the marshes are as remarkable for their flowers as for their birds. The great rose mallow is doubtless the most beautiful, as it is also one of the most abundant species, acres sometimes being pink with the bell-shaped flowers. There are also brilliant cardinal flowers, sagittaria, pickerel weed, jewel flowers, all of which are shown in the group, and many other species.

The studies for this group were made about one mile south of Little Ferry, N. J. The view shown is toward the west.

With the so-called "march of civilization," all this wealth of bird and plant life is bound to disappear, to be replaced by railways, factories and docks.

Wild Turkeys in West Virginia
Background by Bruce Horsfall. Birds by H. C. Denslow.

THE WILD TURKEY IN THE MOUNTAINS OF WEST VIRGINIA

THE Wild Turkey, in spite of its name, is distinctly an American bird, which formerly ranged throughout the wooded portion of the eastern United States, from southern Maine and southwestern Ontario, south to Florida and southwest to New Mexico and Arizona, whence it extends southward onto the Mexican tableland.

It has now become rare or extirpated in the more settled portions of its range and is rarely found as far north as Pennsylvania and Ohio.

Throughout its wide range, the Wild Turkey presents some variations in color, the extremes of which are shown by the Eastern Wild Turkey and the Mexican Wild Turkey. These birds differ chiefly in the color of the tips of the tail-feathers and upper tail-coverts, which in the eastern bird are chestnut, and in the Mexican bird, whitish.

Singularly enough, our barnyard Turkey is descended from the Mexican bird, which the Spaniards found among the Aztecs in a state of domestication. It was introduced from Mexico into Europe, where it had become well established in 1530, and from Europe was brought by the colonists to eastern North America.

Although the domesticated bird will readily cross with the wild one, no extensive effort has been made to domesticate the latter, and the inhabitants of our barnyard still show the whitish-tipped tail and tail-coverts of their Mexican ancestors.

Florida Great Blue Heron

Background by Bruce Horsfall. Birds by H. C. Denslow.

FLORIDA GREAT BLUE HERON

THE Great Blue Heron, often miscalled "Crane," is distributed throughout North America. On the humid northwest coast it is darker than in eastern North America; in the arid Great Basin region it is paler; and the Florida form shown here, known as Ward's Heron, is somewhat larger than the others.

Herons are more aquatic than Cranes and feed largely on fish. In the Eastern States they invariably nest in trees, but in the West they often nest among the reeds like Coots. Young Herons are born in a more or less naked condition and are reared in the nest; Cranes are hatched with a downy covering and can run about shortly after hatching. Herons fly with a fold in the neck, but Cranes keep the neck outstretched.

On the ground the Heron is a rather homely object, with his lanky form and long legs and neck, but in flight, his neck folded, the great wings, slowly flapping, bear him on his stately way. Rarely he sets his wings and soars grandly in lofty circles.

In hunting, he either stalks patiently, lifting his feet and setting them down with the greatest deliberation and care, or stands even more patiently waiting. In either case a lightning-like thrust of his beak brings the frog, fish, reptile or even mouse which constitutes his fare.

The Great Blue Heron's eggs are pale blue, unmarked, two and a half inches long. Three or four form a set.

The Heron's notes are loud squawks.

The Sandhill Crane in Florida

Background by Bruce Horsfall.   Birds by Herbert Lang.

THE SANDHILL CRANE ON THE KISSIMMEE PRAIRIES

IN 1632, when Morton wrote of New England birds, "of Cranes there are a great store—they sometimes eate our corne and doe pay for their presumption well enough—a goodly bird in a dishe and no discommodity," he referred to the species in this group. At that time it was doubtless common throughout North America; now it nests in Florida only of the Atlantic Coast States, while in the interior it breeds only west of the Mississippi.

In Florida, the Sandhill Crane is still to be found on the great Kissimmee Prairies and their adjoining low, pine-grown lands, where the studies for the present group were made. Here, in March, it commonly builds its little island nest in the water-filled depressions thickly grown with a species of pickerel weed locally known as "bull-tongue."

Nest-building is preceded by the singular antics of courtship, when both males and females hop, skip and jump about one another, bowing low and leaping high, all the time croaking and calling. Their matrimonial affairs settled, one hears only the loud but sonorous trumpeting of the male which, when heard near by, is harsh and rasping, but, when softened by distance, becomes one of the most attractive sounds of a Florida dawn.

Although superficially resembling Herons, Cranes are more nearly related to the Rails. Young Cranes, like young Rails, are born thickly covered with down, and they run shortly after leaving the egg. The young Heron, on the contrary, is hatched scantily covered with hair-like feathers and spends over a month in the nest. Cranes further differ from Herons by flying with the neck fully extended (see the birds in the painting), while Herons fly with a fold in the neck which brings the head nearly back to the shoulders.

Cranes are less aquatic than Herons. One may see them walking about the pine woods or over the prairies, dignified, stately figures, hunting for seeds, roots, grasshoppers, snails or lizards, while near the water, frogs are captured.

The Snake-Bird or Water-Turkey

Background by Bruce Horsfall. Birds by Ernest W. Smith

THE ANHINGA, OR WATER-TURKEY, IN FLORIDA

THE fact that the Anhinga resembles both a turkey and a snake sufficiently to have received the names "Water-Turkey" and "Snake-bird" is an excellent commentary on the peculiarity of the bird's appearance and habits.

The first-mentioned name finds its origin in the highly developed, broadly tipped, turkey-like tail. The second relates to the long, slender, snake-like neck, and when the bird swims with its body submerged and only the long, shining neck, head and sharply pointed bill above the water, the resemblance to a serpent is greatly increased. (See bird in group.) It may be added that the bird's book name of "Anhinga" is of Portuguese origin and means snaky.

The Anhinga is equally at home in the water and high in the air, combining in an unusual manner the habits of an aquatic and an aërial bird. Its form, close plumage and broadly webbed feet—all four toes being united by membranes as in the Cormorants—admirably fit it for life in the water, and it not only dives with great ease, but pursues and captures its prey under water, the tip of the bill being provided with fine, tooth-like serrations to enable it to grasp its slippery victims.

After prolonged submersion the Anhinga's plumage, in spite of its texture, becomes more or less saturated with water, hence the bird, while drying its feathers, stands with wide-open wings. (See bird at right.)

The Anhinga's webbed feet make it at home in the water, but it is the bird's tail which renders it, for a diving bird, equally at ease in the air. With spread wings and tail it soars in circles, hawk-like, for long periods, evidently for the pleasure it finds in this exhilarating form of exercise.

Anhingas are hatched naked and are reared in the nest, which is a remarkably well made structure. When a few days old, a buff down begins to appear, which soon covers them. Like the young of Pelicans and Cormorants, they secure their food from the parent's throat.

The background represents a "bonnet," or yellow pond lily lake with its surrounding cypresses and palmettoes, 17 miles west of St. Lucie, Florida.

A Glimpse of Pelican Island, Florida

Background by Bruce Horsfall. Birds by Ernest W. Smith.

THE BROWN PELICAN ON PELICAN ISLAND, FLORIDA

BROWN Pelicans normally nest in bushes, and when the birds first came to Pelican Island, Florida, the island was covered with mangroves, in which the birds placed their nests. Severe frosts and over-use by the Pelicans have killed all but a few trees. When these are occupied by from two to five nests each, the remaining birds build their nests on the ground, most of them resorting to a sand-bar at the east end of the island, where they are as thickly grouped as the painting indicates.

The young Pelican (ground nest, front, left, in the group) is born naked. When about ten days old a downy plumage begins to appear, which soon changes the bird from black to snowy white (ground nests, rear and front). The brown flight-plumage now begins to grow, showing first in the shoulders and humeri (ground nests, front, center and right), and at the age of about two months this plumage is fully developd.

The young are fed on predigested fish regurgitated by the old bird into the tip of the pouch (ground nest, left, rear). Later the young birds (sometimes all three at once) eagerly thrust their heads into the parent's mouth and get their first fish from the base of its pouch. Possibly in this habit may be found the origin of the myth in which the parent Pelican opens her breast to supply nourishment for her offspring. When the young Pelican secures fish longer than it can swallow, it sits with the tail projecting from its mouth, patiently waiting for the head to digest (ground nest, center, front).

The inhabitants of Pelican Island have often been wantonly molested by man, and at times the vandalism of tourists, who killed the birds and robbed them of their eggs, has threatened the existence of this remarkable colony. To prevent so unfortunate a catastrophe, President Roosevelt set aside Pelican Island as a government reservation, and a warden is employed to guard it during the nesting season. Only visitors who have secured a permit from this warden are allowed to land on the island.

The American Egret in a South Carolina Cypress Forest

Background by Bruce Horsfall. Birds by Herbert Lang.

THE AMERICAN EGRET IN A SOUTH CAROLINA CYPRESS FOREST

ANYONE who knows how abundant the Snowy "Herons" or Egrets once were in our Southern States may be surprised to learn that no little difficulty was experienced in finding a locality where the necessary studies could be made for an Egret group. So effectively, indeed, have the plume-hunters done their work, that it was feared that this beautiful and fast-vanishing species could not be included among the Habitat Groups, when, quite by chance, a colony of Egrets was heard of on a shooting preserve in South Carolina. It appears that when the land was acquired it contained a few Egrets, survivors of a once flourishing colony. The new owners rigidly protected them, and they soon began to increase, forming at the end of seven years a rookery which would have done credit to the days of Audubon.

The nests were in cypresses at an average height of forty feet, and the birds were studied and photographed from a moss-draped blind attached to the limb of a tree forty-five feet above the water.

Sketches for the background were also made from the trees in order to secure the desired effect of height.

The plumes or "aigrettes," for which this Heron and its near relatives inhabiting the warmer portions of the world have been slaughtered, are worn by both sexes. They are acquired prior to the nesting season and constitute the birds' wedding costume, to be displayed as the pose of the bird in the group indicates. As the season advances and they become frayed and dirty, they are shed.

All statements that such plumes are obtained from birds kept on "Egret Farms" are absolutely false.

Aigrettes are to be secured, therefore, only during the period of reproduction, and this fact, added to the Heron's communal habits, accounts for the surprising rapidity with which the birds have been brought to the verge of extinction. Concealed in the rookery, it is a simple thing to shoot the parents as they return with food for their young; and in the early days of "pluming" it was not unusual for a man to kill several hundred birds at a sitting.

The Turkey Buzzard

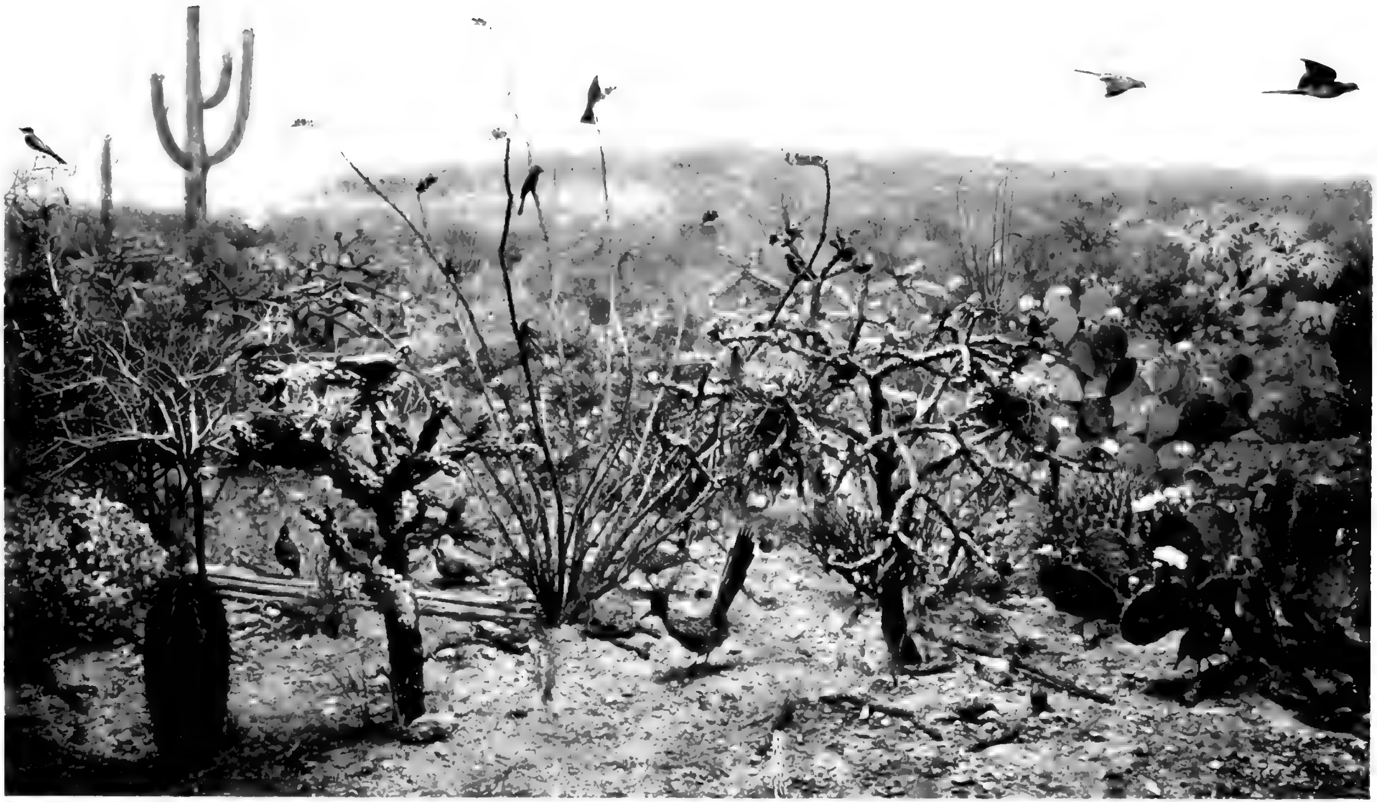
Background by Hobart Nichols. Birds by Herbert Lang.

TURKEY BUZZARD

WIDELY distributed over temperate and tropical America, the Turkey Vulture—or, as it is more commonly called, Turkey Buzzard—is a familiar bird in many parts ofthe South, where it may be seen gravely stalking about in search of food or gracefully soaring in wide circles overhead.

As Bendire has written: "They look their best aloft as their flight is exceedingly easy and graceful, while the apparent absence of all effort as they sail in stately manner overhead, in ever changing circles, and without any apparent movement of their well shaped wings, makes them really attractive objects to watch; but let them once descend to the ground or alight in a tree, and attractiveness ceases; now they are anything but prepossessing, and it requires no effort to place them where they properly belong—among the scavengers of the soil."

The locality shown is Plummer's Island, in the Potomac, just above Washington, looking up the river toward a stretch of rapids known as Stubblefield Falls. This island is the headquarters of the Washington Field Naturalists' Club, an organization that includes many of our best known naturalists, and is their favorite week-end resort.



A Cactus Desert and its Bird-Life

Background by Bruce Horsfall. Birds by H. C. Denslow.

A CACTUS DESERT AND ITS BIRD-LIFE

THE great cactus-covered deserts, so characteristic of the more arid portions of Mexico, push a well developed arm northward into Arizona, forming too marked a feature of North American scenery to be omitted from any series of representations designed to include at least the more pronounced types of our landscape.

Since this region has no colonies of birds, and no one bird of sufficient size to be treated alone, it was decided to prepare a group which should show its common birds as well as its commoner forms of vegetation.

Tucson, in southern Arizona, was selected as a suitable locality for our studies, throughout which we had the invaluable advice of Dr. D. T. MacDougal, Director of the Desert Botanical Laboratory of the Carnegie Institution, which is situated at this point.

At the time (May 9-20, 1906) of our visit the desert vegetation was at its best, and looking out over the variously colored blossoms it was difficult to believe that we were not in a land of great fertility.

The birds of this region, like its plants, are of Mexican origin. Along the "washes," which after rains in the mountains are streams for a brief period, mesquites and acacias grow abundantly, and here such brightly colored birds as Cardinals and Vermilion Flycatchers are found. Where this irregular but natural type of irrigation is lacking, the vegetation is chiefly of cactus which, affording but little shelter for birds of bright colors, is inhabited chiefly by species of neutral-tinted plumage.

Here Mockingbirds and Thrashers (chiefly *Toxostoma curvirostre palmeri*), Cactus Wrens, Roadrunners, Gambel's and Scaled Quail, Texas Nighthawks, Inca, White-winged and Mourning Doves and Black-throated Sparrows abounded, while Gilded Flickers and Crested Flycatchers (*Myiarchus*) nested in the giant cacti.

The making of the vegetation for this group called for unlimited skill and patience on the part of the preparator. Every joint of cactus shown is a facsimile reproduction of the original. Before making the plaster molds, every one of the hundreds of spines was carefully removed. After the casts had been taken from the mold (the Opuntia in wax, the others in plaster) they were colored from field studies of growing plants, and the original spines were then set in their proper places.

California Condor in Piru Cañon

Background by Charles J. Hittell. Bird by Ernest W. Smith

THE CALIFORNIA CONDOR

LEWIS and Clark found the California Condor as far north as the Columbia River in Oregon, and, at this time, it was distributed southward through California to northern Lower California. This was assuredly a surprisingly restricted range for a bird possessing such unusual powers of flight; but it now occupies an even smaller area, being found only in the Coast Ranges of southern California, from Monterey County southward.

The Condor's rapid decrease is believed to have been occasioned by its feeding on the poisoned carcasses of cattle exposed by ranchmen as bait for bears, panthers and wolves. Since these predaceous animals have now become exterminated or greatly decreased, this unfortunate custom has been abandoned and the Condor is now holding its own.

The California Condor weighs from 20 to 25 pounds, and while not so heavy a bird as the Condor of the Andes, slightly exceeds it in stretch of wing, the average California Condor measuring about nine feet from tip to tip. When flying, the Condor bears a strong resemblance to the Turkey Buzzard, but when the two are seen together the Condor's much greater size is pronounced, while its white under wing-coverts are conspicuous as the bird soars overhead.

The Condor lays its single egg in crevices in the rocks or in caves without pretense of nest, in February and March, and the researches of Finley and Bohlman show that the young bird is between four and five months old before it makes its initial flight.

Studies for the present group were made in Piru Cañon, some twenty miles north of the village of Piru, and fifty miles southeast of Santa Barbara, where for many years a pair of birds had nested in a cave which pierced the vertical cañon wall 150 feet above the water. From this cave were taken, when young, the Condors now (1915) living in the National Zoölogical Park in Washington, D. C.

The visitor is supposed to be in the Condor's cave, from which he looks up the cañon. The cave was not occupied at the time the studies were made, a passing hunter having wantonly shot one of the birds.

Condors were also found by the Museum expedition up the Agua Blanca, a tributary of the Piru, on one occasion seven of the magnificent birds being in sight at once.

Brandt's Cormorant at Monterey, California

Background by Charles J. Hittell. Birds by Herbert Lang.

BRANDT'S CORMORANT AT MONTEREY, CALIFORNIA

VISITORS to Monterey, California, on the Southern Pacific R. R., who have taken what is known as the "Seventeen-Mile Drive," may recall the rocky islet standing in the Pacific about a quarter of a mile off the coast near Cypress Point. This islet and the Cormorants which each year nest upon it are shown in this group.

Brandt's Cormorant also nests on other islets off our Pacific Coast, and it is a regular visitor to the rocks off the Cliff House at San Francisco, where, however, it does not nest.

Both when flying and when resting upon the water the Cormorant suggests a large duck. The resemblance, however, is superficial, the Cormorant being related to the Pelicans, Gannets, Anhinga and all other birds which have the hind toe connected with the front toes by a web.

The Cormorant is an expert diver and catches its food of fish by pursuing it under water, the hooked bill of the bird doing good service, while the broadly webbed feet propel it at great speed. It is the skill of the Cormorants in fishing that has led both the Chinese and Japanese fishermen to train the birds to act as assistants to them in pursuit of their calling.

The young Cormorant, in common with other members of its order, and unlike the downy young of ducks and geese, is hatched naked and passes more than a month in the nest. The young secure their food by thrusting their heads down the parent's throat. At first sight one might easily imagine that the old bird was trying to swallow its offspring.

When the young bird is a few days old, a thick black down begins to appear on it. Shortly after this coat becomes complete, it is succeeded by the flight plumage. This is dull brownish black, the glossy plumage of maturity being acquired later. As special adornments of the breeding season both the male and female Cormorants don certain spiny, white nuptial feathers on the back or about the head and neck, while the bare skin of the cheeks and pouch becomes brightly colored. In Brandt's Cormorant, as will be observed, the pouch is rich blue and the birds appear to distend it for the purpose of display.

Cormorants, like their near relatives, are virtually voiceless, a harsh, rasping call being their only note.

Summer Bird-Life of an Irrigated Portion of the San Joaquin Valley, California

Background by Charles J. Hittell. Birds by H. C. Denslow.

SUMMER BIRD-LIFE OF AN IRRIGATED PORTION OF THE SAN JOAQUIN VALLEY

AT Los Baños, in the San Joaquin Valley of California, the waters of the San Joaquin River are used to flood vast areas to create grazing land for cattle. The region is naturally dry and arid, but irrigation soon transforms the desert into a series of creeks, ponds and marshes. The desert plants are replaced by *Sagittaria*, *Ranunculus*, tulés and cat-tails and the desert birds give way to a remarkable assemblage of water birds, whose local distribution is governed by the presence or absence of water.

Driving along a levee, which extends as far as the eye can reach, the old and the new life is found to be separated only by the width of the dike. On the left is a parched and sterile plain with Horned Larks, Burrowing Owls, Jack-rabbits, Coyotes, Rattlesnakes and other characteristic desert forms; while on the right are water and fertility, with Ducks, Herons, Ibises, Coots, Stilts, Avocets and other aquatic species in countless numbers.

To the east the view stretches across the desert toward the distant Sierras, where on clear days may be seen the snow fields which, eighty miles away, supply the water at one's feet. To the west (the view represented in the group), one looks over green marshes and shining ponds fairly twinkling with flitting wings, to yellow fields leading up through molded brown foothills to the crests of the Coast Range.

The group contains only the commoner birds of the region—Black-necked Stilts, Avocets, Killdeer, Black and Forster's Terns, Black-crowned Night Herons, White-faced Glossy Ibises, Coots, Mallards, Pintails, Cinnamon Teal, Ruddy and Fulvous Tree Ducks.

While it is true one would not find all these species in a space eight by twenty feet, one could frequently see all or most of them in a single glance, and the impression the group seeks to convey is therefore within the truth.

The sudden changes occasioned by the irregularity of the water supply are often disastrous to the birds nesting here. The homes of birds which begin to nest before the water has reached its height are sometimes flooded, while the withdrawal of the water deprives the birds of its protection and makes their nests and eggs accessible to marauding animals.

A Flamingo Colony in the Bahamas

Background by L. A. Fuertes (birds) and Charles J. Hittell (landscape). Birds by Herbert Lang.

A FLAMINGO COLONY IN THE BAHAMAS

BEFORE the studies for this group were made, very little was known about the nesting-habits of Flamingoes. For this reason, and because of the belief that a reproduction of a Flamingo city (beyond question the most remarkable sight in the world of birds) would possess exceptional interest, an expedition was dispatched to the Bahamas in 1902, to find Flamingoes on their nesting grounds. It was unsuccessful; but in 1904 the search was resumed, and on this occasion the birds were discovered, and from an artificial blind, concealed in the very heart of their rookery, containing 2,000 birds, a series of unique photographs and observations was made.

The birds begin to lay their eggs early in May. Their nests are constructed by scooping up mud with the bill and patting it down with bill and feet. The nests are raised to a height of from eight to fourteen inches to protect their contents from a subsequent rise in the water.

Both sexes incubate; one by day the other by night. The young are hatched covered with down, like young ducks. They remain in the nest three or four days and during this period are fed by the parents on predigested juices of a mollusk of the genus *Cerithium.* (See standing bird at the left and also the sitting bird at the right, which is brooding and is about to feed.) They also eat the shell of the egg from which they have so recently emerged.

The singular shape of the bill of the adult Flamingo is related to the manner in which it secures the small spiral *Cerithium* shells which, in the Bahamas, appear to constitute its only food. To obtain them, the bill is pressed into the soft mud until its point turns upward. The lower mandible moves rapidly, forcing out the mud and water through the channels along the sides of the bill and leaving the shells.

It will be noted that the bill of the young Flamingo is essentially straight, but when about two weeks old the curve becomes evident and the young bird begins to feed as does its parent.

When a month old, a second downy plumage is acquired (see bird at right), and at the age of two months, this is replaced by a dress of brownish feathers (see bird at the left). In October or November this is probably followed by the pink plumage of maturity, since no brown birds are seen in the spring.

Boobies and Man-o'-War Birds on Cay Verde

Background by Bruce Horsfall. Birds by Herbert Lang.

THE BOOBY AND THE MAN-O'-WAR BIRD IN THE BAHAMAS

CAY VERDE is a coral islet, some forty acres in area, situated about two hundred and thirty miles southeast of Nassau in the Bahamas. Like all reef keys, it is at the junction of a bank with the ocean, and the background clearly shows how sharply the dark blue water, indicating the great depths of the sea, is separated from the lighter water over the shallow banks.

Cay Verde was reached on the "Physalia," a small yacht which the Marine Biological Laboratory of the Carnegie Institution placed at the disposal of the Museum for this occasion. The voyage was begun at Miami, Florida, on March 28, 1907, but unfavorable weather, including a severe storm, in which the "Physalia" narrowly escaped being wrecked, delayed the arrival at Cay Verde until April 8. The Cay has no fresh water and its only vertebrates are birds, one species of snake and two of lizards.

The Boobies, of which there were about 1500 pairs, nested only on the ground, making little or no nest. They were so tame that one could walk about among the sitting or brooding birds without causing them to leave their eggs or young. As a rule Boobies lay two eggs; but the second is apparently not laid for about a week after the first, and as a rule only one hatches.

The two or three hundred Man-o'-War Birds which lived on Cay Verde placed their nests in the dense growth of "sea-grape" and cactus which covered a portion of the Cay. They lay but one egg. The young acquire a covering of whitish down when a few days old, and this is quickly followed by a surprising development of the feathers of the back, which it will be observed more than cover the back before the corresponding feathers appear in the young Booby.

The male Man-o'-War Bird has the remarkable habit of inflating its red gular or throat-pouch until it resembles a toy balloon. The birds sit on their nests or even fly about displaying this surprising appendage.

With a wing expanse of between seven and eight feet and a body no larger than that of a hen, the Man-o'-War Bird is one of the most-powerful and graceful of flyers. It feeds largely on flying-fish, which it catches in the air.

American Egrets in Cuthbert Rookery
Study for the group from Nature.

Cuthbert Rookery Group
L. A. Fuertes making sketches for the background.

A FLORIDA ROOKERY

"ROOKERIES" are, or rather were, one of the characteristic features of the bird-life of Florida. The term is generally applied there to all gatherings of roosting or nesting birds, whether Pelicans, Cormorants or Ibises, but, because of their commercial importance, one more frequently hears of Heron rookeries. Before the demand for their plumage had brought the aigrette-bearing Herons and Roseate Spoonbill to the verge of extermination, a Florida rookery was one of the most remarkable sights in the bird-life of our country.

One may still find colonies of Ibises, Cormorants, Pelicans and plumeless Herons, but of those great gatherings of birds which were once so abundant, Cuthbert Rookery appears to be the only one remaining. Here only will one find the birds just named and with them American and Snowy Egrets and Roseate Spoonbills. It seemed therefore especially desirable to make studies there on which to base a representation of this almost vanished phase of our bird-life.

As may be imagined, Cuthbert Rookery has continued to exist only because of its remoteness. It is situated in the heart of the great mangrove swamp which borders the Everglades at the extreme southern part of the state. So shallow is the water off this part of the Florida coast that the sharpie bearing the Museum expedition, although it drew only two and a half feet, could not approach nearer the shore than seven miles, and five hours were required to reach land by pushing and poling in small boats. In four hours more, following narrow passages through the dense mangroves, Cuthbert Lake was reached. The Rookery is on a small islet, about a mile from the entrance to the lake. At this time (March 29, 1908) it was estimated to contain about 35 Roseate Spoonbills, 15 Snowy Egrets, 350 American Egrets, 50 Little Blue Herons, 2000 Louisiana Herons, several hundred Ibises and a few Cormorants and Water-Turkeys. Only the Spoonbills, Herons and Egrets were nesting.

The group is designed to show a portion of the rookery with the birds nesting and roosting in the mangroves, while the background portrays the whole islet at evening when the birds are returning.

A Golden Eagle's Nest in Bates s Hole, Wyoming

Photograph from Nature of the scene reproduced in the group.

THE GOLDEN EAGLE IN WYOMING

THE Golden Eagle ranges throughout the mountainous parts of the Northern Hemisphere. In North America it is now very rare east of the Rocky Mountains, but from the Rockies west to the Pacific, and north to Alaska, it is not uncommon. In the mountains, the bird nests on cliffs, but in California it often builds in trees, white oaks being frequently chosen.

Although the Golden Eagle is powerful enough to prove a dangerous antagonist, it never attacks man, in spite of sensational stories to the contrary. Even when its nest is approached, the bird makes no attempt to protect its young, but either disappears entirely, or, calling, circles high in the air.

Eagles, like most raptorial birds, nest early in the year. They usually lay but two eggs, which hatch after thirty-five days' incubation. The young remain in the nest about two months. The natural food of the Golden Eagle in the west consists chiefly of small mammals of various kinds, such as prairie dogs, rabbits, squirrels, spermophiles and rats, together with ducks, geese and grouse. Occasionally it takes a young deer or antelope. On the whole, however, under natural conditions, the Golden Eagle is a beneficial bird because of the large number of rodents it destroys. But where sheep have been introduced, the Golden Eagle may become more or less injurious through its acquired habit of preying on lambs.

Four species of Eagles have been recorded from America north of Mexico. Of these the Gray Sea Eagle, an Old World species, is found in this hemisphere only in Alaska; and the Harpy Eagle, a tropical species, has been recorded but once, from Texas. This leaves virtually only two North American species, the Golden and the Bald Eagle. When the Bald Eagle is mature, with a white head and tail, the two species are very unlike in color, but before the Bald Eagle acquires its distinctive marks, it bears a general resemblance to the Golden Eagle. The latter, however, has the legs feathered to the toes, while in the former the lower part of the "legs" (tarsi) is bare.

Whistling Swan

Background by Hobart Nichols. Birds by Walter Escherich.

WHISTLING SWAN ON SOUTHAMPTON ISLAND, HUDSON BAY

A SWAN on the nest, as shown here, is a conspicuous object, visible far across the arctic tundra, which is the home of this species. The human population is scant, however, and the powerful birds have been known to kill a marauding fox. The nest is built of moss, etc., raked up in the immediate vicinity, and in it are laid two to five white eggs, four and a quarter inches long. Both male and female share the labor of nest-building, of the thirty-five days of incubation, and of caring for the young. The latter are clothed in white down, but this is soon displaced by a grayish plumage, in which the young swans, called cygnets, travel south with their parents in the autumn.

Swans feed chiefly on the grasses and tender water-plants they pull from the bottom, reaching downward with the long neck or, if necessary, tilting the body forward till the tail points toward the sky, after the fashion of the common domestic duck and related species. They cannot dive for food as do so many ducks. Small mollusks are also eaten.

Swans are famous for their loud, clear voices, resembling trumpets, horns or other wind instruments.

The Whistling Swan breeds in arctic Alaska and Canada east to Hudson Bay, In winter it is not uncommon locally on the Atlantic Coast south from Maryland and along the Mississippi Valley, Gulf Coast and Pacific Coast. Here in the Northeast it is only a rare migrant, and anyone is very fortunate who ever sees a high-flying flock and hears the far-reaching, clarion calls.

The only other swan in North America is the Trumpeter, now very rare, possibly extinct. It is an even larger bird and lacks the yellow spot in front of the eye.

Whooping Crane

Background by Hobart Nichols. Birds by Walter Escherich.

WHOOPING CRANE

THE Whooping Crane is one of the largest of North American birds and the stateliest. It has been sent down the same road as have so many conspicuously fine species, and now seems on the verge of extinction, for it is rare even in its restricted breeding range and unknown on the Atlantic Coast, where it formerly occurred as a transient. It winters from the Gulf States to central Mexico.

In December, 1811, on the Mississippi, Nuttall witnessed a migration of this species, assembled in a "mighty host. Their flight took place in the night, down the great aërial valley of the river. * * * The clangor of these numerous legions passing along high in the air seemed almost deafening * * * and as the vocal call continued nearly throughout the whole night without intermission, some idea may be formed of the immensity of the numbers now assembled on their annual journey to the regions of the South."

The important differences between Cranes and Herons are noted in the description of the Sandhill Crane group on the opposite side of this gallery. Like other cranes, the Whooping has an elaborate courtship dance, nests on the ground in open country, is nearly omnivorous, and possesses a far-reaching, clarion voice.

The scene here shown is an autumn one on Heron Lake, Minnesota, where thousands of Canvasbacks, Gulls and other waterfowl still congregate, and a very few Whooping Cranes may perhaps yet be seen on migration. The brown and white bird is a young one. One of the adults is trumpeting to the flock passing overhead.

A Klamath Lake Bird Colony

Background by Charles J. Hittell. Birds by Herbert Lang.

KLAMATH LAKE BIRD-LIFE

KLAMATH LAKE is situated in northeastern California on the Oregon boundary-line. Its shallow water permits a great growth of tulés, or rushes, which almost completely fringe the shore, in places expanding to a width of several miles. They also form islands varying in size from a few square yards to many acres in extent. It is on these islands that the bird colonies are established. There is no soil or beach, and all the birds nest on the beds of matted tulés, usually at the border of the island. The White Pelicans, therefore, find here no pebbles with which to construct their usual mound-like nests; the Caspian Terns do without sand, and the Cormorants without rocks. Far more important than these is the protection which ground-nesting communal birds require, and this the islands supply.

Fifteen colonies of White Pelicans were counted in this locality between June 30 and July 7, 1906, and doubtless there were others, since only a part of the bird-inhabited region was examined. There were also great numbers of California and Ring-billed Gulls, Caspian Terns and Farallon Cormorants, while Great Blue Herons, in default of trees, built platform nests of tulés among the growing reeds. White Pelicans feed while swimming, and were here devouring diseased fish which were floating in the water in large numbers, while Brown Pelicans capture their prey by diving; but the young of both species make their first attempts at fishing down the parental pouch, as a comparison of this group with the one of the Brown Pelican on the opposite side of the hall will show. The White Pelican weighs sixteen pounds, twice as much as the Brown Pelican. Its wing expanse is between eight and nine feet and, when in the air, it is one of the most impressive of birds.

The group represents the border of a tulé island, while the background shows other bird-inhabited islets, the surrounding treeless hills, and Mount Shasta in the distance.

Since it was made a land reclamation project has robbed this area of its water and a dusty bottom has now replaced the lake. The birds deprived of their homes have been forced to seek asylum elsewhere. Our studies were made none to soon.

Arctic-Alpine Bird-Life in the Canadian Rockies

Background by Carl Rungius from a sketch by L. A. Fuertes. Birds by Herbert Lang.

ARCTIC-ALPINE BIRD-LIFE OF THE ROCKY MOUNTAINS

WHERE the summits of the Rocky Mountains, Sierras and Cascade Range reach above timber-line to the limits of perpetual snow, the boreal nature of the climate produces conditions favorable for the existence of many plants and animals which, in the Arctic Regions, are found at sea-level. The altitude at which these conditions appear increases as the latitude decreases. For example, in Colorado, at latitude 40°, timber-line is at 11,000 feet altitude, while in Alberta, Canada, at latitude 50°, timber-line is at about 7,500 feet.

Where the area of sufficient altitude is practically continuous the presence of arctic forms of life may be due to extension of range southward; but where it is discontinuous, a boreal area may be separated from a similar region to the north by intervening lower ground, when the occurrence of boreal forms may be attributed to the influence of the Glacial Period. Forced southward during the Ice Age, they were left stranded on these high Arctic-Alpine islands as the ice receded.

The characteristic Arctic-Alpine birds of our western mountains are the White-tailed Ptarmigan, the Rosy Snow Finch (*Leucosticte*) and the Pipit. In the Rockies they are found as far south as Colorado or New Mexico. The Pipit migrates southward in winter, but the Ptarmigan and Snow Finch are practically permanent residents, in winter descending only slightly below timber-line. At this season, as is well known, the Ptarmigan acquires a pure white plumage. (For a seasonal group of Ptarmigan and an explanation of their plumage changes, see the Main Bird Hall.)

The studies for this group were made in the Canadian Rockies about fifteen miles north of Laggan at the Ptarmigan Lakes. The party outfitted at Lake Louise, and ascended the mountains to the northward, from which one obtains a beautiful and impressive view. At the left, beyond Mount Redoubt, in the foreground, lie the peaks of Moraine Lake; in the center is Mount Temple; and to the right, Hungabee, Lefroy and Victoria.

At this season (July 15, 1907) the alpine spring was at its height. The lakes were opening; great white anemones were blooming at the border of the snowfields; the heather was white with little bell-like flowers, and the beds of fluted *Dryas* leaves were starred with blossoms.

Sage Grouse in Wyoming

Background by Charles J. Hittell. Birds by Herbert Lang.

THE SAGE GROUSE IN WYOMING

NEXT to the Wild Turkey, the Sage Grouse is the largest of North American game birds. Its range is restricted to the high, sagebrush (*Artemisia tridentata*) plains of the West, from western Nebraska and western Dakota north to, and in places slightly beyond, the Canadian boundary, west to eastern Oregon and northeastern California, east of the Sierras, and south through Utah and Nevada.

Within these limits the Sage Grouse is resident, but it migrates locally at the approach of winter from higher to lower altitudes, as the snows deprive it of its food. This consists largely of the leaves of the sagebrush, but in summer the leaves and seeds of other plants are eaten. When feeding on sagebrush leaves, the flesh of the old birds is flavored by the nature of their food, but the birds of the year are very palatable.

The Sage Grouse begins to mate very early in the spring, or, in some localities, as soon as late February, and at this season the males indulge in the most remarkable performances, inflating the yellow sacs at either side of the neck, spreading the tail, dropping the wings and strutting like a turkey cock.

The nest is a slight affair, usually placed beneath sagebrush where it is often found by a marauding coyote. The hens hatch the eggs and raise the young unaided by the male, which, when its mate begins to sit, joins with others of its sex to form flocks composed only of males.

When the young are grown the sexes mingle in great bands, which formerly contained thousands of birds. The birds drink night and morning at some regularly frequented spring, about which they sometimes gather so thickly that they must await their turn to reach the water.

This fine grouse is rapidly decreasing in numbers and unless adequately protected will ere long be numbered among the lost species.

The studies for this group were made at Medicine Bow, Wyoming, on the line of the Union Pacific Railway. The mountain to the right is Elk Mountain; those in the distance belong to the Snowy Range of Colorado.

The Love-Making of the Prairie Hen

Background by Bruce Horsfall. Birds by H. C. Denslow.

THE PRAIRIE HEN IN NEBRASKA

ON frosty spring mornings, as the sun rises over the prairies, one may at times hear a singular, resonant, booming note, *boom-ah-b-o-o-m, boom-ah-b-o-o-m*. It is the love-song of the Prairie Hen. He may be near at hand or possibly two miles away, so far does this sound, unobstructed by tree or hill, carry in the clear air. It is well worth following, however, for we may find the maker of it, with perhaps ten to fifty of his kind, engaged in a most remarkable performance.

During the mating season, from March until early in May, the Prairie Hens of a certain district or area gather before daybreak to take part in these courtship demonstrations. The feather-tufts on either side of the neck are erected like horns, the tail raised and spread, the wings drooped, when the bird first rushes forward a few steps, pauses, inflates its orange-like air-sacs, and, with a violent, jerking, muscular effort, produces the startling boom, which we may have heard when two miles distant.

At other times, with a low cackle, he springs suddenly into the air, as though quite unable to control himself, and finally he comes within striking distance of a rival who has been giving a similar exhibition. Then, with much clashing of wings, a fight ensues which often strews the nearby grass with feathers.

These tournaments of display and combat are doubtless designed to arouse the attention of the females, but they also occur when only males are present. Within an hour or two after sunrise, the time varying with the ardor of the birds, the competition is over for the day and the rivals feed peacefully together, until they enter the lists the following morning.

Market hunting has greatly decreased the numbers of Prairie Hens, but on the United States Government Forest Reservation, in the sparsely inhabited sandhills of western Nebraska, on the line of the Chicago, Burlington and Quincy R. R., where the studies for this group were made, they still exist.

The eastern Prairie Chicken, or Heath Hen, was once locally common from New Jersey to Massachusetts, but it is now found only on Martha's Vineyard.

Grebes (Upper Figure) and Wild Goose (Lower Figure) on Crane Lake, Saskatchewan

Backgrounds by Hobart Nichols. Birds by Herbert Lang.

THE WILD GOOSE AND GREBE GROUPS

TWENTY years ago the lakes and sloughs of our more northern plains and prairies were the breeding homes of vast numbers of wildfowl of many species, but the demands of agriculture have forced the birds to find new haunts north of the Canadian boundary. There, too, if proper protection is not accorded them, they will again be dispossessed by the advance of civilization.

Crane Lake, Saskatchewan, near the line of the Canadian Pacific, where the studies for both the Goose and Grebe groups were made, is typical of many similar resorts of wildfowl in western Canada. In the vicinity of and about the border of sloughs and lakes there nest Willets, Marbled Godwits, Long-billed Curlew, Killdeer, Avocets, Wilson's Phalaropes, Shovelers, Gadwalls, Mallards, Pintails and Blue-winged Teal; while among the reeds and tulés Western and Eared Grebes, Franklin's Gulls, Black Terns, Redhead and Canvas-back Ducks, Ruddy Ducks and Coots build their homes. The Geese resort to islands where also Ring-billed and California Gulls, Common Terns and Pelicans are found. Favorable islands are also selected by Ducks, and on the island shown at the right in the background of the Grebe group, Messrs. Bent and Job estimated that on June 17, 1905, "at least 150 pairs of Ducks were breeding or preparing to breed."

The Wild Geese arrive from the south before the ice leaves the lakes, and lay their eggs early in May. The young birds in the group were taken on June 15, 1907, when they were about two weeks old. Grebes' nests are mere platforms of water-soaked vegetation. These eminently aquatic birds walk with difficulty and their homes must therefore be near the water. They leave the nest at the slightest alarm, but usually first cover their eggs with a part of the nesting material. One of the birds is shown in this act.

The young swim soon after hatching and for a time are carried on the back of the parent.

The background in both groups shows the rolling, treeless plains with, in the Goose group, a line of dune-like sandhills, where, among the low bushes, Sharp-tail Grouse are found.

Loon on Lake Umbagog

Background by Hobart Nichols. Birds by Jenness Richardson.

LOON; GREAT NORTHERN DIVER

LOONS, like Grebes, are among the most aquatic of birds. All their feeding is done in the water, and their nests are always so placed that the sitting bird can slide quickly into and under the water. They live almost entirely upon fish. These they chase under water, swimming for the most part with the feet alone. Baby loons hatch covered with dense, dusky down, and can swim almost at once. While many Loons spend the winter along shore, often fishing close to the beach, more keep far out, even fifty miles or more from land all the season. When one does come out on land, both bill and wings are used to help the unaccustomed feet.

Though wintering on salt water, the Loon nests largely on the fresh-water lakes of the North in scattered pairs. There may be heard its wild cry, "one clear, piercing note or a long, quavering, demoniacal laugh, that to the timid suggests a herd of screaming panthers. It is one of the stirring, inspiring sounds in nature." In winter the birds are silent and dressed quietly in brownish-gray above and white below.

This species breeds in the northern part of North America, Europe and Asia, and winters from about the southern edge of its breeding range to southern Lower California, the Gulf Coast, Florida, the Mediterranean Sea and China.

Camp on Cay Verde, Bahamas

AMERICAN MUSEUM OF NATURAL HISTORY

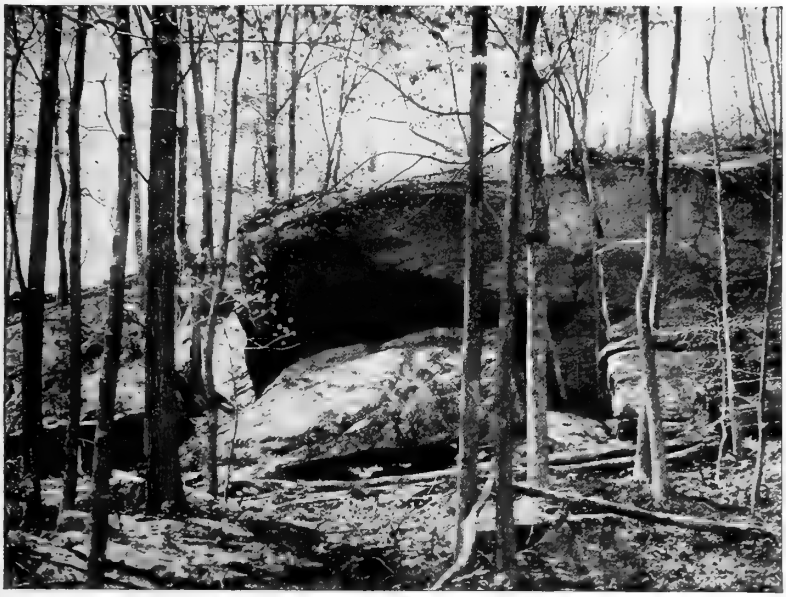
FOR THE PEOPLE

FOR EDUCATION

FOR SCIENCE

AMERICAN MUSEUM OF NATURAL HISTORY

The Indians of Manhattan Island and Vicinity



AN INDIAN ROCK HOUSE IN GREATER NEW YORK

By ALANSON SKINNER

Department of Anthropology

GUIDE LEAFLET NO. 29

SEPTEMBER, 1909

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members..............	$ 10	Fellows....................	$ 500
Life Members.................	100	Patrons....................	1000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year.

* Deceased.

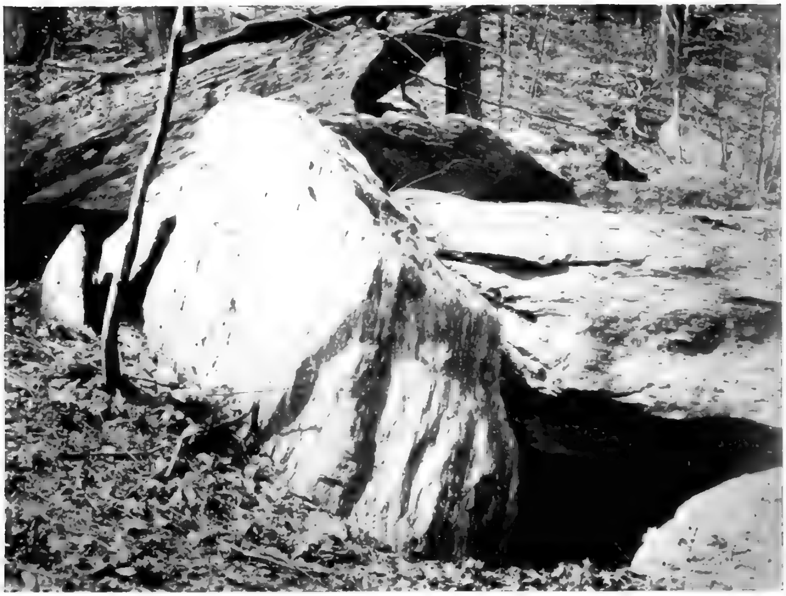


FIG 1 INWOOD ROCK-SHELTER MANHATTAN

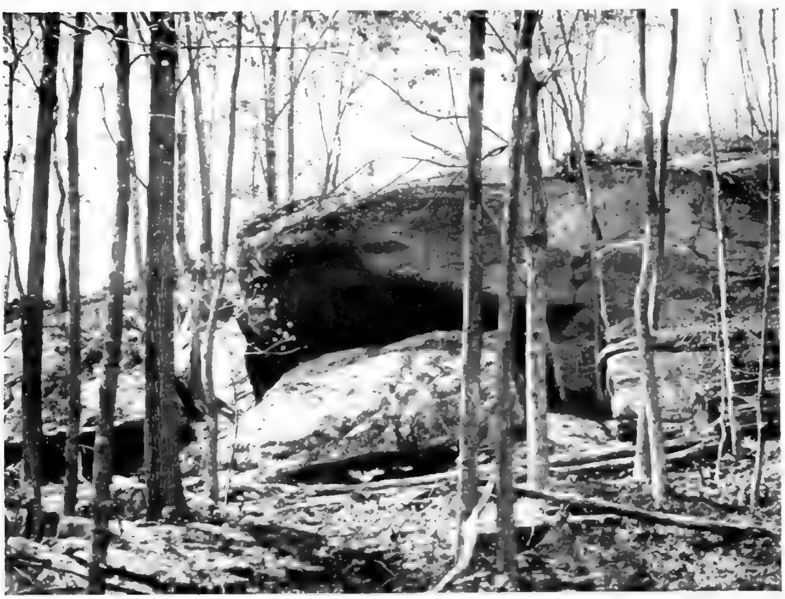


FIG 2 FINCH S ROCK HOUSE

The Indians of Manhattan Island and Vicinity

By ALANSON SKINNER
Department of Anthropology

A GUIDE TO THE

HUDSON-FULTON EXHIBIT

AT THE

American Museum of Natural History

NO. 29

OF THE

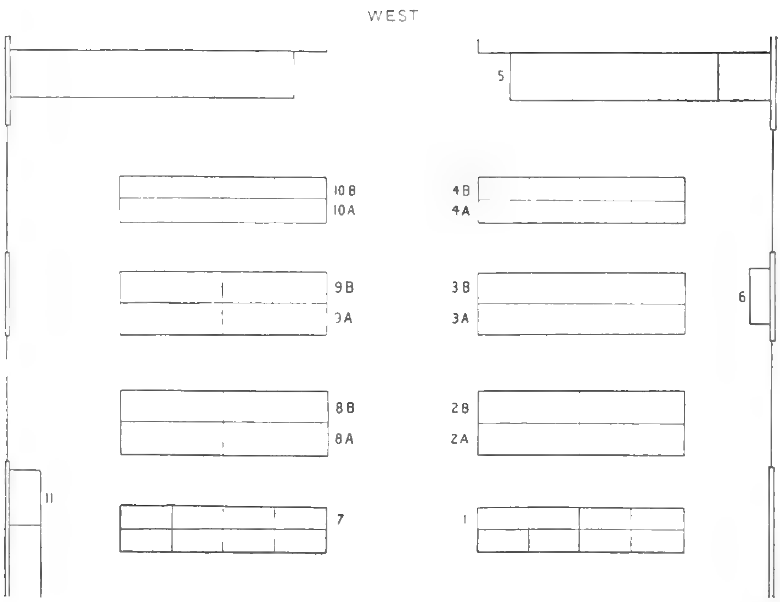
GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. September, 1909



FLOOR PLAN, WESTERN END OF THE HALL OF THE PLAINS INDIANS

(No. 102).

Explanation of Case Numbers.

1 Mohegan and Delaware. Iroquois: Clothing; Weapons.
2A Prehistoric Life in Greater New York.
2B Prehistoric Manhattan Island.
3A Shinnecock Hills, Long Island.
3B Van Cortlandt Park. Long Island.
4A Iroquois: Corn Food; Household Utensils.
4B Iroquois: Transportation; Games; Ceremonial Objects; Wampum.
5 Iroquois Group.
6 Shell Heap.
7 Iroquois: False Face Society.
8A Westchester County.
8B Upper Hudson.
9A Kah Kwah and Erie Indians of New York State.
9B New York State. Articles of European Manufacture.
10A Pottery of Greater New York. Husk Face Society.
10B Bolton and Calver Collection.
11 Rock Shelter.

THE INDIANS OF MANHATTAN ISLAND AND VICINITY.

By Alanson Skinner,

Department of Anthropology.

Introduction.

As a part of the Hudson-Fulton celebration, a special exhibit representing the Indians of New York has been arranged in the West Hall, on the ground floor of the Museum. The low, or table cases, contain implements of stone, bone, shell and other materials, found on Manhattan Island and in and around Greater New York,— implements once used by the Indians occupying this region. In the upright cases will be found ethnological objects, many of which are still in use among the surviving Iroquois Indians of New York State. This guide, therefore, refers chiefly to the remains of Indians found upon Manhattan Island and adjacent shores, examples of which are shown in the table cases. The location of the various cases may be seen from the accompanying plan.

In using this guide, the visitor is advised to turn north, as he enters the exhibit and take a general view of the cases in the order designated; then it is suggested that he follow the discussion (pp. 14–36) of the various kinds of specimens found near New York City as he makes a second examination of the exhibits in the table cases.

The Hudson-Fulton exhibition is designed to show the life of the Indians of New York City and vicinity in prehistoric times, when primitive conditions were as yet unchanged by the advent of European settlers. The objects shown have been collected by Museum expeditions sent for the purpose of excavating the ancient village, camp and burial sites of the Indians in several localities within the area indicated, and the exhibits have been prepared from the remains thus secured. The remnants of the tribes that once occupied the primeval forests of Greater New York have so long been scattered and lost that almost nothing can be obtained from them now.

Beginning with the northern half of the exhibit, the visitor will find the first section of the upright case (1)[1] devoted to a few specimens showing some of the more perishable articles formerly in use among the Delaware and Mohegan Indians of this immediate vicinity. Most of these have been collected from the scattered remnants of these people, or else were obtained from old families who, since the disappearance of the natives, preserved

[1] See diagram on page 4.

articles of Indian manufacture in their homes as curiosities. The other portions of this case exhibit the clothing and weapons of the Iroquois.

The first table section (2A) is devoted to an exhibition, as comprehensive as possible, showing the life of the natives in prehistoric times by means of specimens obtained from the ancient village and camp sites. Here may be seen bones of the various animals, fish and shell-fish upon which the Indians depended for subsistence; fragments of nuts, corn, roots and other food products preserved by charring and obtained from ancient fireplaces, and such implements as arrow points of antler and stone, net-sinkers of stone and stone hoes for tilling the fields — all illustrative of primitive methods of hunting and agriculture. Implements exhibited in the same case show the preparation of animal and vegetable food with primitive utensils, while close by are tools used by the Indians in preparing skins. The manufactures of the Indians are illustrated in the immediately adjacent section (2B). A progressive series of implements shows the making of an arrow point from a simple quartz pebble such as might be picked up anywhere on the shore, with the various stages leading to the finished point; the tools employed are also exhibited. Implements of stone for pecking, grooving and polishing; hatchets and axes; pottery fragments, and household utensils, such as hammers, axes, adzes and gouges, will be found at hand.

In the other side of this table case (2B) there is an exhibit from Manhattan Island, made up of specimens principally collected by Mr. Alexander C. Chenoweth in the rock-shelters and village sites at Inwood, showing as fully as possible the life of the prehistoric Manhattan Indians. The exhibit illustrating, by means of models, the manufacture of pottery is especially noteworthy. From the appearance of fragments now to be found on the sites of the ancient Indian villages of this vicinity and the methods of modern Indian pottery makers, we may safely conclude that most, if not all, of the earthenware manufactured in this locality was made by the "coil" process, which consisted of the following steps. The Indians first secured clay of a suitable quality, which was mixed with pounded shell or stones to make it tougher and more durable. It was then worked into long rolls, and the Indian, beginning at the bottom, worked the pot up by adding coil after coil, blending or smoothing the coils with a smooth stone until they did not show from either the interior or exterior surface. The potter's wheel was not known to the aborigines in the olden days. When the pot was completed, it was decorated by stamping or incising designs about the exterior of the rim.

In the next table case (3A) are to be seen implements and remains from the shell heaps marking the long-forgotten Indian villages at Shinnecock Hills, Long Island. This exhibit, which is one of the most complete of its kind, gives a rather adequate picture of the ancient life of these people

and is especially valuable for the number and variety of primitive manufactures shown. One of the most interesting of the sections demonstrates, by means of a series of specimens, the primitive methods of cutting bone and antler employed by these Indians. Bone was cut by notching or grooving it with a stone knife or flake and then breaking it at the groove. Antler was worked in the same way, but it is very probable that the Indians boiled antler in order to make it more pliable and easily cut.

In the western side of this case (3B) there is a series of specimens collected from an ancient Indian village situated on the site of the Parade Ground at Van Cortlandt Park. In the adjacent section some specimens from Long Island in general are shown.

The upright case (4A) at the end contains an exhibit from the Iroquois Indians of New York State, and the small wall case (6) on the side shows a section of a shell heap with a map showing the location of most of the

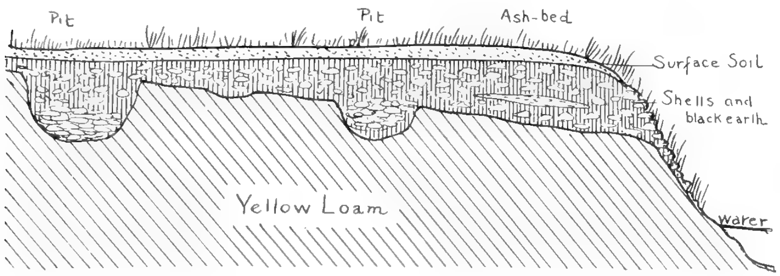


FIG. 3. DIAGRAM OF A TYPICAL SHELL DEPOSIT.

Indian villages of Greater New York and vicinity, as well as photographs and labels describing the opening and excavation of the sites. Specimens typical of those found in the shell heaps are also exhibited.

Of all the traces left by the aborigines along the New York seacoast, the most abundant and familiar are the shell heaps — the beds of refuse marking the sites of ancient villages, camps and isolated wigwams. Wherever the fresh water joins the salt and especially where open water for fishing, a creek with its clam beds and a spring for drinking come together in happy combination, there is generally to be found some such evidence of Indian occupation, unless, as is often the case, settlement and improvement have buried deep the shells or carted them away.

The typical "shell heap" is not a heap at all, for leaf mold, the wash from neighboring high ground and often cultivation have made it level with its surroundings (Fig. 3). Very often, unless the land be plowed, no shells whatever show on the surface, and the only way of finding out the conditions

of things below the sod is to test with a spade or a crowbar. If shells are present, their crunching soon gives notice of the fact. Sometimes shell heaps have been located by shells thrown from mole and woodchuck burrows, or by outcropping in gullies washed by the rain, or banks broken down by the surf. They are generally located near some creek or bay on low but dry ground, preferably with an eastern or southern exposure, and, as before mentioned, not far from drinking water. Some have been found fronting on the open Sound, but such cases are rare. These deposits consist of large quantities of decayed oyster, clam and other marine shells mixed with stained earth, with here and there ashes, charcoal and fire-broken stones to mark the spots where ancient camp fires blazed. Among

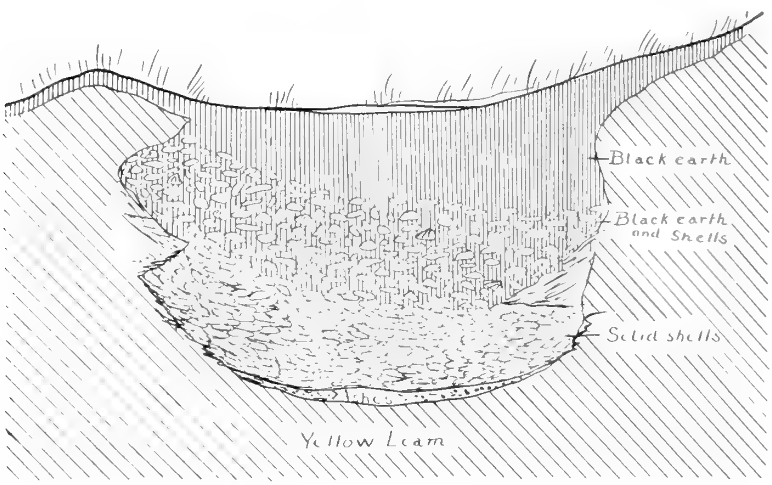


FIG. 4. CROSS SECTION OF A SHELL PIT.

the shells are usually scattered antlers of deer, fish bones, bones of animals and birds split for the marrow, quantities of pottery fragments, and broken implements, in short, the imperishable part of the camp refuse left by the Indians. Now and then, perfect implements and ornaments that had been carelessly lost in the rubbish or hidden for safe-keeping are discovered. Little did the Indian think, as he laid away his little hoard, that his handiwork would never see light again until he and his people had long been gone and forgotten.

Shell heaps vary from a few inches to four feet in depth, and in area from a few square yards to several acres — all depending on the length of time the settlement was occupied and the number of dwellings comprising it. Deep shell heaps are often divided into layers, the lowest of which are, of

course, the oldest. Under and near most of these deposits may be found scattered "pits" or fire holes, which are bowl-shaped depressions in the ground filled with layers of stained earth, shells and other refuse, with an occasional layer of ashes. Some pits are as large as ten feet wide by six feet deep, but the average is four feet deep by three feet wide. It is supposed that they were used as ovens or steaming holes and afterwards filled up with refuse (Fig. 4). Some contain human skeletons, which may have been interred in them during the winter season when grave digging was impossible.

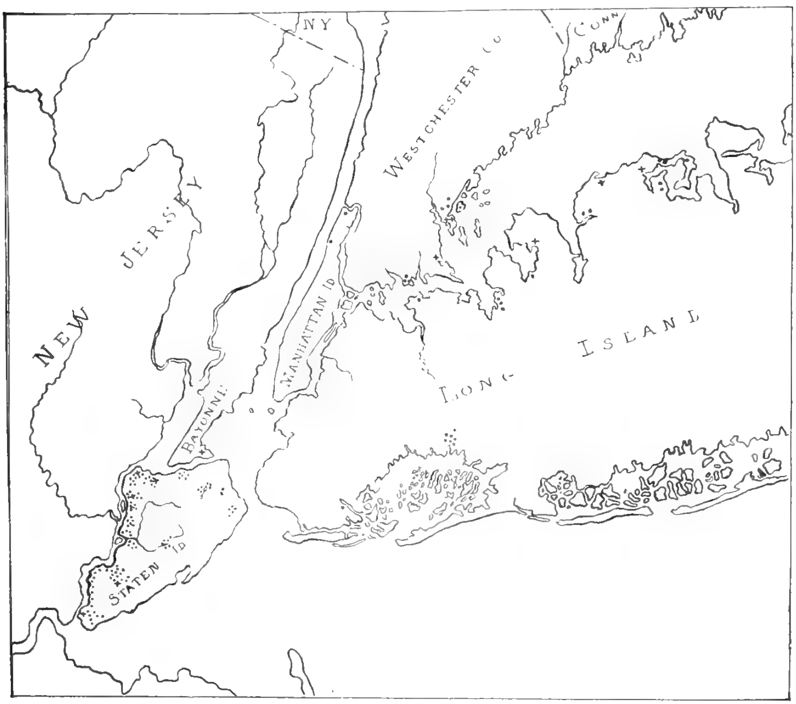


FIG. 5. MAP GIVING THE LOCATIONS OF SHELL DEPOSITS.
Those marked + have been explored by the Museum.

Pits as a rule, contain more of interest than the ordinary shell layer. The closely packed regular masses of shells form a covering which tends to preserve bone implements, charred corn and such perishable articles from decay in a way that the looser shells of the general layers fail to do.

Shell heaps, while abundant along the seacoast, are seldom found inland, except on salt creeks or other streams having access to salt water. They may be seen all along the east shore of the Hudson River at more or less

frequent intervals up as far as Peekskill, and on Croton Point and between Nyack and Hook Mountain on the west shore they attain considerable size. There are a few small deposits, however, composed mainly of brook clams (Unio) situated on fresh water lakes in the interior of Westchester County. There are many shell heaps on Staten Island. Shell heaps occur or did occur on Constable Hook, New Jersey, and at intervals between there and Jersey City along the western shore of New York Bay. The accompanying map (Fig. 5) gives the location of the important known shell deposits of the vicinity of New York City.

FIG 6. GRAVE OF SKELETONS WITH ARROW POINTS.

On the opposite side (4B) of the upright case, the Iroquois exhibition is continued, but the last section is devoted to a small exhibit showing the manufacture of wampum by the Indians of Long Island with prehistoric implements and a number of specimens of wampum belts and strings collected from the Iroquois of New York and Canada.

The wall case (5) at the western end of the room contains a group illustrating the costumes of the Iroquois Indians of a period from about 1790 to the present day.

Beginning on the south side of the aisle, the easternmost upright case

(7) is devoted to the False Face Society of the Iroquois, while the table case (8A) immediately following contains objects from Westchester County and Staten Island. In these sections an interesting feature of aboriginal life is shown. Although most of the Indians of the vicinity of Greater New York did not place objects in the graves with their dead, some graves at Burial Ridge, Tottenville, Staten Island, when opened for the Museum in 1895, were found to contain a great many interesting and valuable remains. With the skeleton of a child there was a great deposit of utensils, both finished and unfinished ornaments, such as beads, pendants, and the like, a stone pipe and a number of other objects, while not far away the skeletons of three Indian warriors were exhumed (Fig. 6), in and among whose bones there were found, as shown in this section, twenty-three arrow points of stone, antler and bone (Fig. 7).

This is an excellent exhibit indicating the use of the bow in Indian warfare. The skeletons lay side by side with the legs flexed as shown in the illustration (Fig. 6). In the first skeleton, it was found that two points of antler and one of bone had pierced the body and lodged near the spinal column. Another point of argillite had been driven between two ribs, forming a notch in each. A bone arrow point had struck the shoulder and was resting against the scapula. Among the bones of the right hand, an arrow point of antler was discovered, and there was a similar one near the left hand. Another antler point was lying in the sand just beneath the body and had, no doubt, dropped from it when the flesh wasted away. The most interesting wound of all was one where an antler-tipped arrow had ploughed through one side of the body and fully one-third of the point had passed through one of the ribs, making a hole, where it remained, as smoothly as if drilled. The second body was also terribly injured. The left femur showed an elongated puncture near the lower end, probably made by an arrow point. Among the ribs was the tip of an antler point, and a yellow jasper one was among the ribs on the left side of the body. Three other points were among the bones. The third skeleton was likewise an example of old-time bow play. There was an antler point among the ribs on the left side. The end of one of the fibulæ was shattered by a stone arrow point, and a second point had lodged between two ribs. Beneath the sternum was a flint point, and the right shoulder blade showed a fracture near the end, caused by a blow of some hand implement or an arrow. Near the base of the skull, the end of an antler arrow point was discovered, broken perhaps by its impact with the occiput. Two bone points were near the lower bones of the left leg. A second point was found upon search among the left ribs; under the vertebræ was the base of another antler point, and two broken points were found beneath the body.

FIG. 7. BONES PUNCTURED BY ARROW POINTS, FROM SKELETONS FOUND ON STATEN ISLAND.

The position in which several of the points were found certainly speaks well for the great force which propelled them. The long bows of the local Indians must indeed have been formidable weapons. Taking into consideration the number of arrows which must have been imbedded in the bodies of the warriors, it is perhaps probable that the majority of the projectiles were driven into the victims at close range after death.

In the wall case (11) south of the exhibit will be found the model of a rock-shelter and typical objects found in such places. These, as the name implies, are protected spots in rocky ledges, where Indians once made more or less permanent places of abode. Many such shelters exist in the vicinity of New York, one or two having been discovered at Inwood, Manhattan (Fig. 1). The most important rock-shelter so far discovered is the so-called

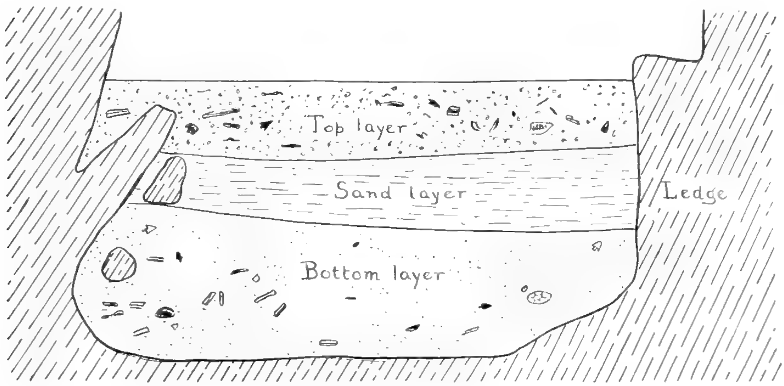


FIG. 8. VERTICAL SECTION OF REFUSE IN FINCH'S ROCK HOUSE, ABOUT MIDWAY OF THE CAVE

Finch House (Fig. 2) reproduced in the model. The original is near Armonk, Westchester County, New York. One point of special interest is the fact that the Finch shelter contained two layers bearing relics separated by sand as shown in the drawing (Fig. 8). As no pottery was found in the bottom layer, it has been inferred that we have here the remains of two different races of Indians, the older not yet advanced to the pottery-making stage. This conclusion, is, however, far from final, for the whole arrangement may be due to accident.

The table case 8B contains objects selected from the Henry Booth collection illustrating the life of the Indians of the Upper Hudson. They are especially interesting on account of the number of ceremonial "banner stones" found in that region, which are apparently not nearly so abundant anywhere else in this vicinity.

In the next table case the section 9A is devoted to the life history of some of the Iroquois tribes other than the Five Nations of western New York, and the following section (9B) shows, as well as possible, the culture of the Iroquois Indians of central New York and objects used by the Indians of New York State in general manufacture or obtained from the Europeans upon the advent of the settlers. In the upright case (10A) there is presented an exhibition of pottery vessels, all but one of which were found within the limits of Greater New York, and some implements from the Iroquois of the Mohawk Valley, besides material illustrating the societies of the Iroquois. On the other side, (10B), the entire case is filled with specimens from the Bolton and Calver collection from Manhattan Island, which will be more fully described below.

The Types of Indian Relics found in and about New York City.

Having now taken a general view of the exhibit, the visitor may be interested in a study of the several kinds of relics found in this locality. As these types are somewhat different from those found in near-by regions, we conclude that the Indians formerly living here had habits and customs different from those of their neighbors. For want of a better name, these long-extinct tribes have been called the New York Coastal Algonkin. The term Algonkin designates the language they spoke, while the adjective defines their habitat.

In the term New York Coastal Algonkin, the writer includes the tribes along the coast from Tottenville, Staten Island, the extreme southern point of the state, to the Connecticut boundary on Long Island Sound, including to a certain extent the shores of New Jersey immediately adjacent to Staten and Manhattan Islands, the east bank of the Hudson River as far north as Yonkers, and exclusive of Long Island except the western end. From the examination of the remains of the New York Coastal Algonkin area preserved in many collections, both public and private, it becomes obvious that the objects found may be roughly divided into three groups: articles of stone, articles of bone and antler, and articles of clay, shell and metal. The first group is, from the imperishable nature of its representatives, naturally the largest and comprises a number of sub-groups to be briefly described and commented upon in this paper. Examples of this type will be found in the table cases previously mentioned. For the following descriptions and historical notes the author has largely drawn on Mr. James K. Finch's and his own contributions to Volume III of the "Anthropological Papers of the American Museum of Natural History" (New York, 1909).

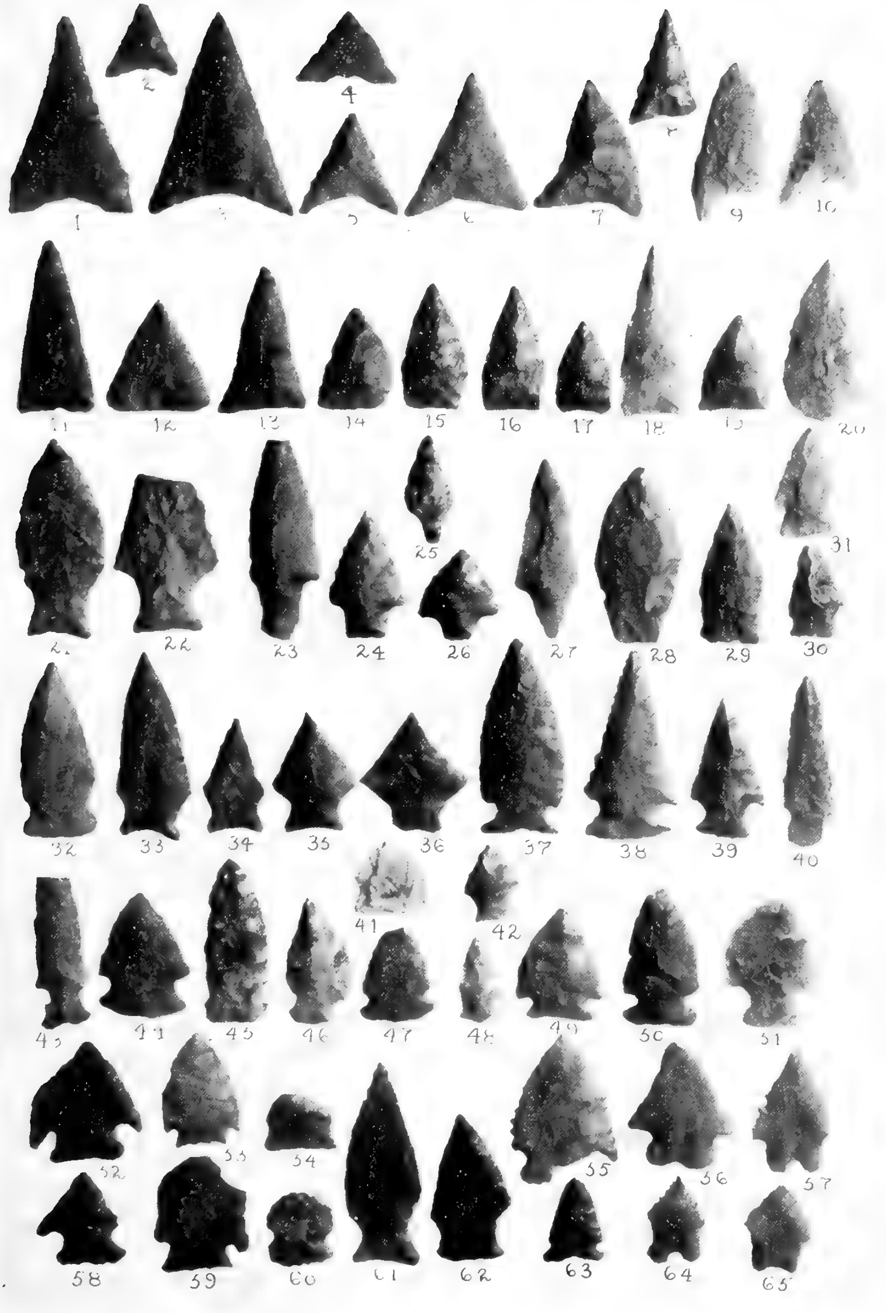


FIG. 9. TYPES OF ARROW POINTS.

Chipped Articles.

Arrow Points (Fig. 9). Two general types may be recognized, and these are the stemmed or notched, and the triangular forms. The former are by far the most abundant, and while these are usually made of the nearest local rock possessing the necessary conchoidal fracture, in some cases they are of material brought from a long distance. Specimens made of pink flint resembling stone from the Flint Ridge of Ohio, and of jasper found to the south of this region have been recorded. Blunt arrow points are rare, the Indians probably preferring wooden arrows for this type. Many of the so-called "blunt-points" found in collections, appear to be scrapers made over from broken arrow points of a large size.

The triangular type has long been regarded by the local collectors of this vicinity as being the type used in war, the argument being that as it has no stem, it was necessarily but loosely fastened in its shaft and, if shot into the body, would be very liable to become detached and remain in the flesh if any attempt were made to withdraw it by tugging at the shaft. While it was no doubt perfectly possible to fasten a point of triangular shape to the shaft as firmly as a notched point, the discoveries of Mr. George H. Pepper at Tottenville, Staten Island, where twenty-three arrow points were found in and among the bones of three Indian skeletons, tend to strengthen this theory. While the majority were of bone or antler, all those made of stone were of this type, and indeed most of the bone points were also triangular in shape. However, it is well to bear in mind that arrow points of triangular type have been used for every purpose by all the early Iroquois tribes of New York.

Spear Points and Knives (Fig. 10). None of the early accounts of contemporary European writers seem to mention the use of spears (other than bone or antler-headed harpoons) by the Indians hereabouts, and it is probable that the larger arrow-point-like forms found were used as knives or cutting tools. They are usually notched or stemmed, rarely triangular, and occasionally round or oval. They vary in size, but it must be remembered that one tool may have had various uses, and that drills, knives and scrapers may often have been combined in one implement.

Scrapers (Figs. 10 and 11). Scrapers were probably used in dressing skins, and in sharpening bone implements, woodworking and for various other purposes. These are usually mere flint flakes chipped to an edge on one side. Nevertheless, notched and stemmed forms, requiring some care in their making do occur. Broken arrow points were occasionally chipped down to serve this purpose. A single serrated scraper has been found.

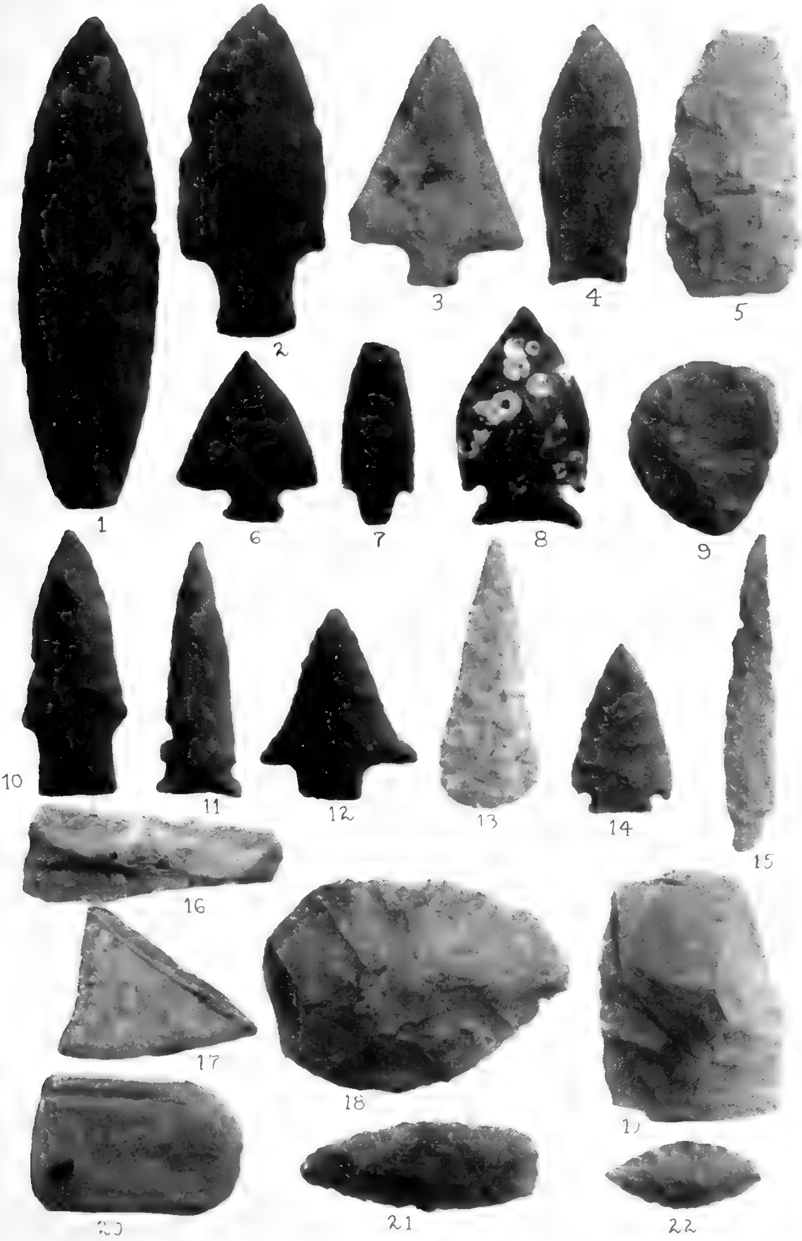


FIG. 10. KNIVES AND SCRAPERS

These are very rare in both the Algonkian and Iroquoian areas of New England and the Middle Atlantic States. One very large stemmed scraper, of a type more common in the far west, also comes from this locality.

Drills (Fig. 11). These are usually chipped tools presenting an elongated narrow blade and a considerably swollen or expanded base, suitable for grasping in the hand. In some cases the base was absent and those were probably hafted in wood. Specimens whose blades have a square or rectangular cross section are very rare. The finding of cores left in half-drilled objects shows the use of a hollow drill, and it has been suggested that a hard hollow reed used with sand and water on a soft stone would produce this effect. To bear out this assertion, it has been reported that a half-drilled implement has been found (outside this area on the upper Hudson) in which the remains of the reed drill were found in the cavity left by its action.

Rough Stone Articles.

Hammerstones. These vary from simple pebbles picked up and used in the rough, showing merely a battered edge or edges acquired by use, to the pitted forms. They are generally mere pebbles with a pit pecked on two opposite sides, perhaps to aid in grasping with the thumb and forefinger. Some have battered edges, but many have not, suggesting, when round and regular, a use as gaming or "Chunké" stones, or as implements used only in pounding some soft substance. Hammerstones, pitted on one side only, and others with many pits on all sides, occur. These latter may have had some special use, and are not to be confounded with the large flat, slab-like stones having pits only on one side, found in other regions, and perhaps used as receptacles for holding nuts while cracking them. While these are common in the Iroquoian area, they are unknown here.

Large stones, single or double pitted, resembling oversized hammerstones occur, and these may have been used as anvils in chipping flint or for like purposes.

Grooved clubs or mauls, also showing use as hammers are found. These are rare and are usually either rough pebbles, grooved for hafting, as in the case of the grooved axe, or grooved axes, the blades of which have become so battered, broken and rounded by wear as to preclude their further use for chopping.

Net-sinkers. On all sites near the water, either salt or fresh, net-sinkers show the prevalence of fishing. These are of two types. In one case a pebble is notched on opposite sides of either the long or broad axis; in the other a groove is pecked around the entire pebble in the same manner. The

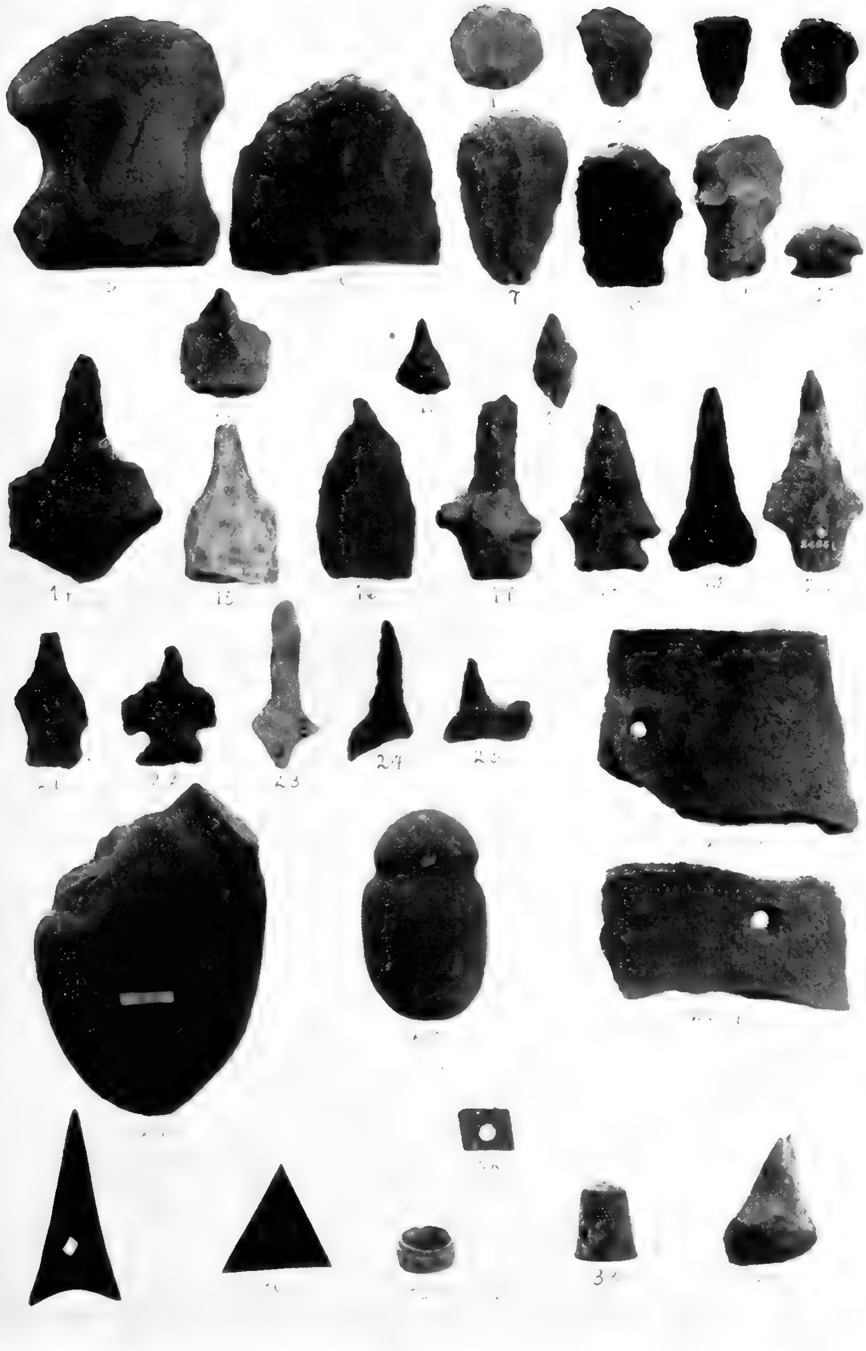


FIG. 11. DRILLS, SCRAPERS AND OTHER OBJECTS.

latter type is comparatively scarce, as the former, being more easily and quickly made, was just as useful to the savage. The modern Cree and Ojibway, residing in the forests north of the Great Lakes, still use pebbles for this purpose, but those observed by the writer were not notched or worked in any way. Occasionally, sinkers notched on both axes are found in this region.

Hoes. These are usually ovoid implements, chipped from trap rock and sometimes notched to facilitate hafting, and sometimes not. They usually show a slight polish on the blade, caused by friction with the ground. This stone type of hoe is the form mentioned by early writers; but perhaps hoes of shell, bone or tortoise shell, and wood were used also. None of these, however, are still in existence.

Hand Choppers. Pebbles chipped to an edge on one side, for use as hand choppers, occur. These are occasionally pitted on both sides.

Grooved Axes (Fig. 12). For the purposes of this paper, the writer, while aware that many grooved axes are well made and polished, has decided to include them under the head of "Rough Stone Articles," as by far the greater majority of the grooved axes and celts from this region lack the polish and finish belonging to other articles later to be described. Grooved axes are of two sorts: *a*, those made of simple pebbles, merely modified by grooving and chipping or pecking an edge; and *b*, axes which have been pecked and worked all over and sometimes polished. The latter (*b*) may be said to include:

1. Groove encircling three sides of blade, one side flat.
2. Ridged groove encircling three sides of blade, one side flat.
3. Groove encircling three sides of blade, longitudinal groove on flat side.
4. Groove encircling three sides of blade, longitudinal groove on flat side and opposite.
5. Groove encircling blade.
6. Ridged groove encircling blade.

A seventh type, having a double groove encircling the blade, may occur in this territory, but has never been reported. A specimen from the Hudson River region, just north of the area here dwelt upon, is in the Henry Booth collection in this Museum. While most worked stone axes have been pecked into shape, a few have been fashioned by chipping, but these seem to be rare.

Grooved axes were hafted in various ways. During the summer of 1908, the eastern Cree living in the vicinity of the southern end of Hudson Bay told the writer that their ancestors, who made and used such axes, hafted them by splitting a stick and setting the blade in it, then binding the handle together with deer-skin (probably rawhide) above and below the split. No specimens of the grooved axe in the original haft seem now to be extant

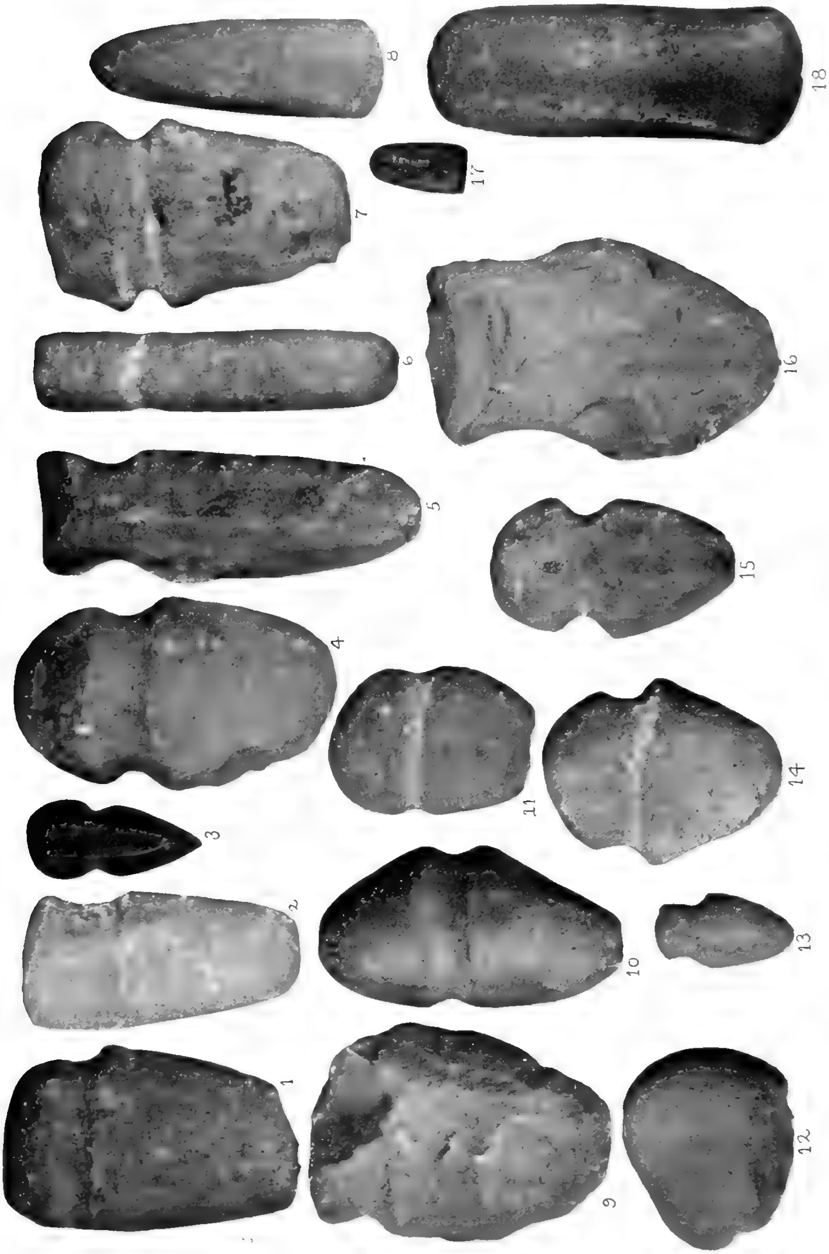


FIG 12. TYPES OF STONE AXES AND CELTS.

from any locality in the East. From the battered appearance of the butts of these axes, it may have been that they were sometimes used in lieu of mauls or hammers. It is possible that they may have been used in war. It is generally supposed that in cutting down trees, making dug out canoes and other kinds of wood-working, fire was used as an adjunct to the stone axe, the former being the active agent. The process of burning and charring having gone on sufficiently, the stone axe was used to remove the burned portion. However, some stone axes seem sharp enough to cut quite well without the aid of fire.

Celts (Fig. 12). Ungrooved axes or hatchets, usually called celts, are frequent throughout this area; but are nowhere as abundant as the grooved axe, especially near the southern border of the region. The grooved axe seems to have been the typical cutting and chopping tool of the local Algonkin. The widespread idea that the celt was sometimes used unhafted as a skinning tool, has no historic proof, but may possibly have some foundation. The Cree of the southern Hudson Bay region use an edged tool of bone for this purpose, a fact which is somewhat suggestive, although the implement differs in shape from the celt. Celts with one side flat and the other beveled to an edge may have been used as adzes. From the worn and hammered appearance of the polls of some celts, it is possible that many of these implements were used as wedges in splitting wood, after constant manipulation in their chopping capacity had permanently dulled their edges.

The celts of this region are, as a general thing, poorly made, a pebble of suitable shape having an edge ground on it with little or no preliminary shaping. More rarely, however, they were carefully worked all over by pecking and polishing, as in the case of the grooved axe.

In type, aside from the general division of rough and worked celts, we may add that most celts in this region have slightly rounded polls, the bit broader than the butt, although some exceptions have been found. The forms are as follows: *a*, rough stone celts, pebbles with one end ground to an edge, but otherwise scarcely worked: and *b*, worked stone celts, which include the following:

1. Wedge-shaped, poll narrower than bit, and angles rounded; common.
2. Like number one, but with bit much broader than poll. Very rare. Cross-section oval.
3. Like number one, but one side flat, other beveled at one end to make a cutting edge.
4. Like number two, but with cutting edge flaring, broader than body. "Bell mouthed type." Very rare.

North and west of this region, we find the Iroquois territory where most

worked celts are angular, having almost invariably a rectangular cross section and squared butt. Types 1 and 3 also occur, but the celt with the rectangular cross section seems most typical of the Iroquoian region. Many small celts, made of flat fragments or chips of stone, are also found in this area, and these could scarcely have had a use as chopping tools.

In the Niagara watershed and extending eastward as far as the Genesee valley, an angular adze-like form having a trapezoidal cross section occurs. It is found principally in what was the territory of the Attiwandaronk,[1] Kah-

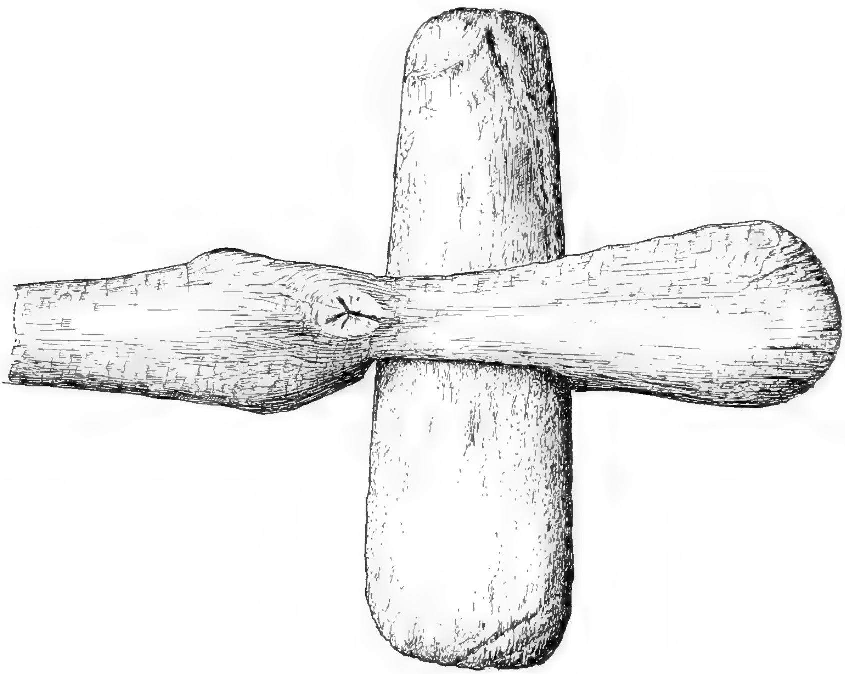


FIG. 13. A HAFTED CELT FROM A POND AT THORNDALE, DUTCHESS CO. N. Y.

Length of celt 16.6 cm.

Kwah, or Neutral Nation (an Iroquoian tribe, early annihilated by the Five Nations). It also occurs, as has been stated, on the sites of villages of the Iroquois proper, but is not abundant. South of the Iroquois in central Pennsylvania, another form which does not occur in this region is the chipped celt, usually of flint or other hard stone. This form is, however, frequent in the country about the headwaters of the Delaware.

In the "American Anthropologist," Vol. 9, No. 2, p. 296 *et seq.*, Mr. C. C. Willoughby has figured and described the celts of the New England

region with remarks on the methods of hafting employed. These seem to be two in number, and consist, in the case of the larger forms, of setting the blade through a hole in the end of a club-like handle, the butt or poll projecting on one side and the blade on the other as in Fig. 13, found in the muck of a pond bottom at Thorndale, Dutchess County, New York, a region once in the Mahican territory. Smaller celts were set into a club-like handle, the butt resting in a hole or socket.

Adzes. These seem to be of two kinds, the first and most simple being celt-like, but flat on one side, the other side being beveled to an edge on one side. The second form differs in having a groove, which is not infrequently ridged. Occasionally, adzes with two parallel grooves occur. They were probably hafted by taking a stick at one end of which projected a short arm at right angles with the shaft, laying the flat side of the blade against this arm and binding it on with sinew, thongs or withes. The groove, of course, was of aid in securing the blade to the handle. Adzes of stone, hafted in this manner, have been obtained on the North Pacific coast. The celt adze seems not uncommon, but the grooved adze is rare, neither form being nearly so abundant as in the New England region.

Gouges. The stone gouge is rare, and seems always to be a plain, single-bladed affair without the transverse grooves so frequently seen in New England specimens, and hereabouts is always easily distinguished from the adze. Less than half a dozen specimens have been seen by the writer from this entire area, although probably quite as much work in wood was done by the New York coastal Algonkin as by the New England Indians.

Pestles. The long pestle occurs throughout the region of the Coastal Algonkin of New York, but is nowhere as abundant as in New England. They seem always to have been used with the wooden block mortar hereabouts, and are mentioned by the early writers as part of the household equipment of the natives. They do not seem to have been used by the Iroquois to the north and west of this area either in early or later times. The wooden pestle of dumb-bell shape seems to have been preferred by them. The latter is used by the Canadian Delaware and may have taken the place of the long stone pestle to a great extent in this region.

Mullers, Grinders, and Polishing Stones. These are frequent, and consist merely of rounded pebbles, shaped and worn by use, probably most often in crushing corn. They are mentioned by De Vries as being used by the Indians with a flat stone slab for grinding corn when traveling. Some seem to have been used for polishing stone implements, but it seems hard to draw the line, as the appearance gained from friction would be quite similar. Such mullers and their attendant slabs, used for preparing corn meal have been collected within a few years in use among the Oneida Iroquois of New York, one specimen being in the American Museum collection.

Sinew Stones. These are pebbles showing grooves along the edges, popularly supposed to have been worn there by rubbing thongs and sinews across the edges to shape them. They occur generally, but are not common.

Stone Mortars. These are common, but rather local, some sites having none at all, and others a good many. One locality on Staten Island is notable for the numbers found there, whereas they are rare elsewhere in that vicinity. They may be divided into the following types:

1. Portable mortar, hole on one side.
2. Portable mortar, hole on both sides (New Jersey type).
3. Portable slab mortar or metate, used on one or both sides.
4. Bowlder mortar, one or more holes, immovable.

The first two types are the most abundant, the third is not uncommon; but the fourth is very rare, only one or two being reported. As above stated, De Vries claims that the portable mortars were used in bread-making, while the Indians were traveling, but certainly the majority of those found are far too heavy for this purpose.

Pigments and Paint-cups. Fragments of pigments such as graphite and limonite, showing the marks of scratching with scrapers, are found, which have apparently supplied the material for painting. Worked geodes are common on many sites. These show traces of chipping in some instances and may have been paint cups. There is a tiny pestle-shaped pebble in the Museum collection from Westchester County, which is said to have been found with a geode of this type. The popular theory is that such geodes were used as "paint cups" and this seems probable.

Stone Plummets. These are very rare, in contrast to their abundance in the New England region. They consist usually of small worked egg-shaped stones, grooved at one end, probably for suspension. The writer has seen but one from this area. Their use is problematic.

Semilunar Knives. Knives of rubbed slate, similar in appearance to the "ulu" or woman's knife of the Eskimo are found, though rarely, in this region. While sometimes ascribed to Eskimo influence or contact, it is possible that this form (which occurs throughout New England), judging by its distribution, may have been native to the eastern Algonkin also. The eastern Cree still use knives of this type as scrapers. Like most other forms common in New England, it is less abundant in the southern part of this area.

Stone Beads. Various pebbles generally perforated naturally are to be found on some sites, and may or may not have been used as beads or pendants. On Staten Island, at Watchogue, Mr. Isaiah Merrill once owned a number of square beads of pinkish steatite (?), all but one of which have been lost, and which he claims were found on his farm.

Polished Stone Articles.

Gorgets. Two types of the gorget occur. These are the single-holed pendant form, which is the less abundant of the two, and the double-holed type. The latter is flat, rectangular in shape and generally well polished. It usually has two perforations a short distance from the middle. The modern Lenapé of Canada claim to have used these as hair ornaments. Probably the two-holed variety is typical of the Algonkian peoples of this region, the single-holed form being on the other hand, the most abundant on old Iroquoian sites. Specimens of the latter have been obtained in use among the Canadian Iroquois, and some of them are in the Museum collections.

Amulets. Certain problematic articles of the "bar" and even "bird amulet" type have been found, but these are probably exotic in origin and are not characteristic of the archæology of the region in question.

Banner Stones. These beautiful polished stone implements of unknown use may be divided into three great classes, with several sub-types as follows:

1. Notched banner stones.
2. Grooved banner stones.
   a. Groove on both sides.
   b. Groove on one side.
3. Perforated banner stones.
   a. Plain.
   b. Butterfly.

All three types seem equally abundant, but the notched banner stones appear to be the oldest form and occur under circumstances pointing to great relative antiquity. They are found, however, on the more recent sites as well. Both notched and grooved banner stones are usually more rough in appearance than the perforated type, and the writer has never seen a polished specimen of the first class. On the other hand, the grooved variety frequently exhibits the high degree of finish characteristic of the perforated forms. Banner stones grooved only on one side are less common than the other forms. While the latter class is generally made of slate, steatite or some similar soft and easily worked material the notched and grooved forms, especially the former, are often formed either from naturally-shaped pebbles or chipped roughly into shape. Implements, usually naturally-shaped stones with little working, without notches, grooves or perforations, but greatly resembling the notched and grooved banner stones in shape, are not infrequently found on aboriginal sites hereabouts and may have served as banner stones. There seem to be neither records nor plausible theories as to their use.

Pipes. Stone pipes, invariably made of steatite, are very rare. Four types have been noted as follows:

1. Monitor or platform pipe, platform not projecting before the bowl.
2. Monitor or platform pipe, platform projecting before bowl, with or without tiny carved stem or mouthpiece. Of the latter, one specimen is known.
3. Trumpet-shaped stone pipe.
4. Rectangular stone pipe, human face carved on front of bowl.

It may be remarked that more stone pipes have been reported from the Indian cemetery at Burial Ridge, Tottenville, Staten Island, than from all the rest of the area put together. The second and third types are represented by one specimen each from Burial Ridge and from nowhere else in this region. Four or five pipes of the first class have been found there as well. The last class is represented by a single specimen obtained by Mr. W. L. Calver at Inwood, Manhattan Island. Undoubtedly the clay pipe was the most common form used in this locality.

Steatite Vessels. These are not at all abundant, though occurring almost everywhere. They were doubtless all imported from New England, as there are no steatite quarries within the range of the New York Coastal Algonkin. The single form found is that common in the east, an oblong, fairly deep vessel with a lug, ear or handle at each end (Fig. 14j). Occasionally, such vessels are ornamented by rude incisions along the rim.

Articles of Clay.

Pottery Pipes are common everywhere. They are usually manufactured of a better quality of clay than that used for vessels, and bear fairly similar designs. They are susceptible of division into the following classes:

1. Straight pipe, bowl expanding slightly.
2. Bowl much larger than stem, leaving it at an angle of forty-five degrees. Stem round.
3. Same as number 2, but stem angular and much flattened.
4. Effigy pipes, (represented by a pottery human head apparently broken from a pipe bowl, obtained by Mr. M. R. Harrington at Port Washington, Long Island).

The straight pipe seems to have been obtained only on Staten Island on the north shore in the region occupied by the Hackensack. While nowhere as abundant as upon the Iroquoian sites of central and western New York, the clay pipe is rather common and is a prominent feature in the coast culture of New York (Fig. 15a). It is more abundant perhaps in the southern part

of the area, but this may well be due to the fact that data from this region are more easily accessible. The triangular-stemmed "trumpet" pipe so common on the Iroquoian sites is unknown in this region.

Pottery Vessels.

The pottery of this region may all be considered as being either the native Algonkian in type or showing Iroquoian influence with a third and intermediate variety. Algonkian vessels may be divided into the following groups according to shape:

1. Conical, pointed bottom, slightly swollen sides, circumference largest at the mouth, — the typical Algonkian pot of this area, Fig. 14a.

2. Like number 1, but much rounder and broader, Fig. 14b.

3. Bottom pointed, sides slightly swollen, neck slightly constricted, Fig. 14c.

4. Identical with number 2, except that just below the beginning of the neck, occur small raised lugs, ears or handles. This is rare from this area, Fig. 14d.

5. Rounded bottom, somewhat constricted neck, lip sometimes flaring, or even turning down and back, Fig. 14e.

The intermediate types are as follows:

6 Rounded bottom, constricted neck, narrow raised rim or collar, Fig. 14f.

7. Like number 6, but with sides more elongated and bottom more oval than round, heavier collar, generally notched angle, with or without a series of small humps or projections at intervals, Fig. 14g.

The Iroquoian types are as follows:

8. Mouth rounded, collar or rim heavy, with humps or peaks at intervals, angle notched, neck constricted and bottom rounded; can stand by itself, an unknown feature in local Algonkian vessels, Fig. 14h.

9. Same as number 7, but with mouth square, and humps at every angle. Much less common than the preceding, Fig. 14i.

In size, the vessels range from small toy-like pots to jars of very large capacity. In general they appear to have been made by the coil process, and are tempered with pounded stone or fine gravel, mica or burned or pounded shell. Sherds showing tempering by fibre or some other substance that disappeared in firing are rarely found. When vessels were cracked or broken, a series of holes was bored opposite each other on either side of the break and the parts laced together, rendering the vessel capable of storing dry objects, at least.

Life forms are exceedingly rare in local ceramic art. From Manhattan Island and Van Cortlandt Park, there come a number of specimens showing incised human (?) faces. This is not an uncommon form on Iroquoian sites in central and western New York. On the Bowman's Brook site at Mariner's Harbor, Staten Island fragments of a typically Algonkian pot were obtained which bore at intervals, rude raised faces. With the sole exception of a rather well-modeled clay face, apparently broken from the

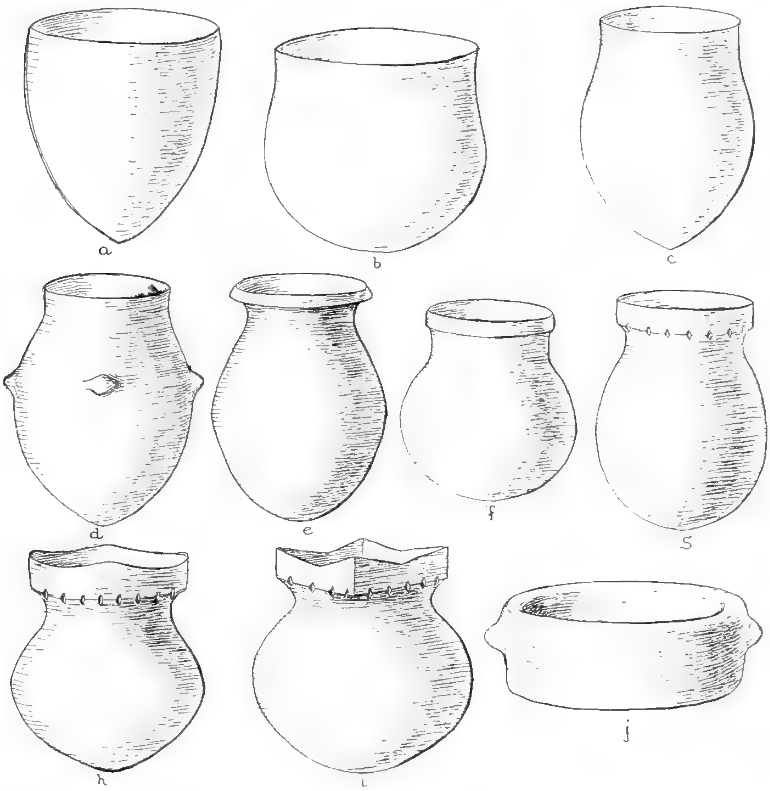


FIG. 14. POTTERY FORMS OF THE COASTAL ALGONKIN.

bowl of a pipe (Fig. 15b) found at Port Washington, Long Island, by Mr. M. R. Harrington, this brief statement concludes the list of pottery life forms reported from this area, although others may yet be found here, since some interesting objects have been collected in immediately adjacent territory.

The forms of decoration consist of stamping with a stamp, roulette or paddle, and incision (Figs. 16 and 17.) Occasionally, but very rarely,

stucco work occurs. Under stamping we can enumerate the following processes:

1. Impression with the rounded end of a stick (rare).
2. Impression with the end of a quill, or hollow reed, leaving a circular depression with a tiny lump or nipple (rare) in the center.
3. Impression with a section of a hollow reed, making a stamped circle (rare).
4. Impression with finger nail (doubtful, but perhaps used on some sherds from Manhattan Island).
5. Impression of the edge of a scallop shell.
6. Impression with a carved bone, antler or wooden stamp.
7. Impression of a cord-wrapped stick.
8. Impression with roulette.

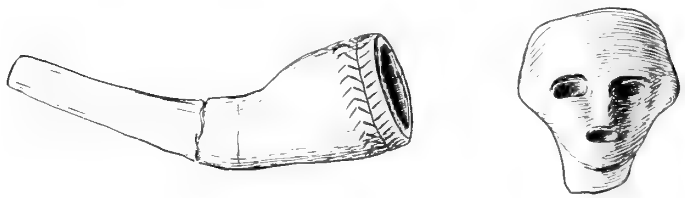


FIG. 15. TYPICAL ALGONKIAN POTTERY PIPE AND FRAGMENT OF AN EFFIGY PIPE FROM PORT WASHINGTON, L. I.

Under the head of decoration by incision we can enumerate the following:

9. Incised decoration, probably made with a stick.
10. Incised decoration, possibly made with a flint object (only one specimen at hand).

The paddle was frequently used to finish the sides and bottom of the pot by imparting an appearance of pressure with fabric when the clay was wet.

11. Stucco. Occasionally, ridges of clay placed on the rim for ornament appear to have been added after the shaping of the vessel.

Ornamentation is usually external, and vessels, either Algonkian or Iroquoian, are rarely ornamented below the rim, although occasionally the designs run part way down the side in the case of the Algonkian forms. Where decoration has been applied by one of the stamping processes, and more rarely by incision, it is sometimes continued over the lip or rim for an inch or less on the inside. This only occurs in the typical Algonkian forms, and is never seen when incised ornamentation is used. The rims of Iroquoian vessels are never ornamented on the interior, nor is stamping so frequently practised on vessels of this class. The intermediate forms, at least the first of the two mentioned, are frequently ornamented on the interior

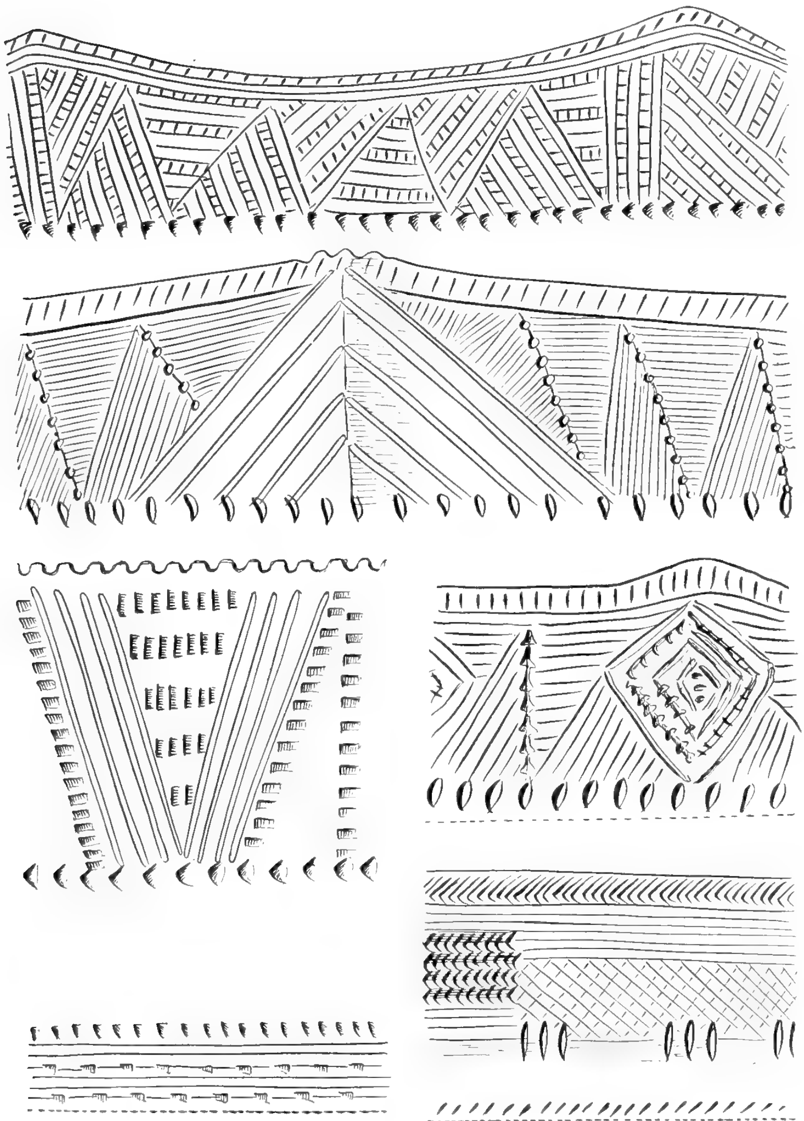


FIG. 16. INCISED DESIGNS FROM POTTERY VESSELS.

a , *b*, and *d*, designs from Iroquoian vessels; *c*, design from an Algonkian vessel; *e*, design from a vessel of the Iroquoian type from a Connecticut rock-shelter, introduced here for comparison.

of the lip. This internal decoration is much more common in the southern portion of this area than elsewhere in the vicinity.

In design, we must of course, give up all thought of trying to obtain symbolism, if such there were, for there are no sources now left upon which to base our assumptions. Certain conventional types of decoration seem to have been in vogue, usually consisting in rows of stamped or incised parallel lines and much more rarely of dots regularly arranged in the same manner. Zigzag, chevron and "herring bone" patterns are the most common, but other angular forms occur, and rows of parallel lines encircling the vessel are sometimes to be found. Stamping and incision as decorative processes never seem to occur on the same vessel. Curvilinear decoration is exceedingly rare, and not enough material is at hand to show that patterns were used, possibly these were scrolls of some form. On account of the lack of material, it cannot be determined whether the designs on the Algonkian

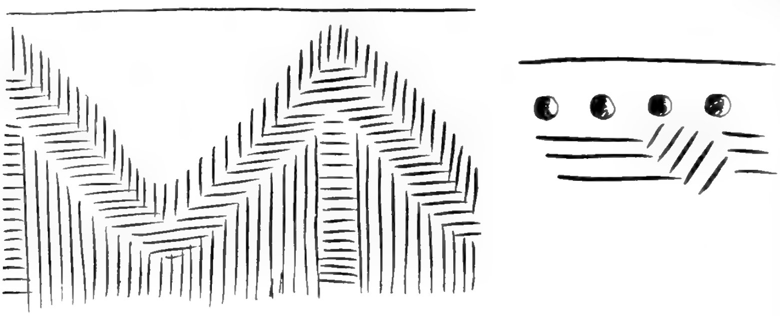


FIG. 17. INCISED DESIGNS FROM ALGONKIAN VESSELS.

vessels differ from those on the Iroquoian, except in a very general and unsatisfactory way.

The angle formed where the heavy rim or collar leaves the constricted neck of the Iroquoian vessel is almost invariably notched, and as such collars and angles do not occur on vessels of the true Algonkian type, this feature is necessarily absent from them. It is noticeable that Iroquoian vessels are usually decorated with incised designs, rather than stamped patterns.

Pottery is found abundantly on the majority of the sites in this district; but, while very much more common than in the New England area, it does not equal in abundance that from the Iroquois country. It is rarely found buried in graves with skeletons as in the Iroquoian area; when sometimes found in graves, however, it is usually at some distance from the human remains and apparently not connected with them. Whole or nearly whole vessels are exceedingly rare and the number of those found up to date may

easily be counted upon the fingers. Potsherds taken from pits or shell heaps, where they have not been exposed to the action of the weather, are often as thickly covered with grease as when they were broken and cast aside.

Articles of Metal.

Beads. Beads of native metal, consisting simply of pieces of hammered sheet copper rolled into small tubes, have been found, but they are very rare. Copper salts, but no objects, were found upon the bones, especially on those of the head and neck, of a child's skeleton at Burial Ridge, Tottenville, Staten Island, which seemed to predicate the use of copper beads. A great many beads of *olivella* shell, some of them discolored by copper salts, were found about the neck of the skeleton. A single celt of copper is said to have been found in Westchester County, probably on Croton Neck, slightly above the limit of the territory treated in this paper.[1]

Articles of Shell.

Wampum. Objects of shell are not at all common, and notwithstanding the coast region of New York was one of the best known localities for wampum manufacture on the continent, wampum beads are almost unknown from local sites. With the exception of completed beads, most of which may have been shipped into the interior, wampum may be found in all stages of manufacture. We refer to the white wampum, for traces of the "black" (blue) wampum made from the hard clam or quahog are so far not reported. The process of manufacture may be shown by shells with the outer whorls broken away in steps until the innermost solid column is reached, ground and polished at the end, and needing only cutting off into sections and perforations to make the finished white wampum bead. These do not occur on all sites, though they have been found here and there throughout the region. Ninety-six conch shells with the outer whorls broken entirely away were found in a grave at Burial Ridge, Tottenville, Staten Island, about the head and neck of a skeleton.

Pendants. Occasionally oyster and clam shells, found unworked save for perforations in them, may have been pendants or ornaments, but certainly have little æsthetic value.

Scrapers. Clam shells seem to have been used as scrapers and some are

[1] Native copper occurs in the New Jersey trap ridges, within a few miles of New York City, an important source in Colonial times being near Boundbrook 30 miles from the lower end of Manhattan Island. Bowlders of native copper occur in the glacial drift. Editor.

occasionally found with one edge showing the effect of rubbing and wearing. These are rare, however. Some may have been pottery smoothers. Clam shells have been reported which contained central perforations and were identical in appearance with some shell pottery scrapers and smoothers collected by Mr. M. R. Harrington among the Catawba. Contemporary writers mention the use of knives made of shell.

Pottery Tempering. This was sometimes done with calcined and pounded shells, but was uncommon, considering the abundance of the material at hand. Pounded stone or gravel seems to have been more favored.

Pottery Stamps. The corrugated edge of a scallop shell was frequently used as a stamp for pottery, as may be seen by examining the potsherds from this region.

Articles of Bone and Antler.

Objects of bone and antler, while perhaps more abundant here than in New England, are far less plentiful in form and number than in the Iroquoian area. Cut bones are frequent in most shell pits and heaps. They were cut by grooving the bone partly through on all sides, probably with a flint knife, and breaking.

Bone Awls. These utensils are the most common of all bone articles in this region and are found in almost every part of the area. Some are merely sharpened slivers, but others show a considerable degree of work, and are well finished and polished. They are usually made of deer or other mammal bone, but sometimes from the leg bones of birds.

In some instances, the joint of the bone is left for a handle, but this is often cut off. Grooved, perforated or decorated bone awls are extremely rare in this region. While it is generally considered that these bone tools were used as awls in sewing leather, as by modern shoemakers, nevertheless, they may have served as forks in removing hot morsels from the pot or for a number of other purposes. The latter supposition is supported by the abundance of bone awls found in some shell pits. The northern Cree of the Hudson Bay region use a similar bone implement as the catching or striking pin in the "cup and ball" game.

Bone Needles. These are rare, but found in most localities. They are generally made of the curved ribs of mammals and are six or eight inches long, or even longer. They are generally broken across the eye, which is usually midway between the ends. A few with the perforation at one end have been reported.

Bone Arrow Points, usually hollow and conical in shape, have been found,

especially at Tottenville, Staten Island, in the Burial Ridge. They are rather rare, but this may be due to the fact that conditions are not suitable for their preservation in most localities. Others are flat and triangular in shape.

Harpoons. No actual barbed bone harpoons, such as occur in the Iroquois country have been reported from this region; although the writer has seen what appeared to be part of one from Shinnecock Hills, Long Island, whence comes a harpoon barb of bone, found by the writer, now in the Museum collection, which was apparently made to tie to a wooden shaft. While neither of these forms seems to occur within this region, several naturally barbed spines from the tail of the sting-ray, found on the Bowman's Brook site, at Mariner's Harbor, Staten Island, may have been used as harpoons or fish spears, for which purpose they were admirably suited by nature. Long, narrow, chipped stone arrow-heads are generally called "fish points", but they do not seem peculiarly adapted for this purpose and the name is probably a misnomer. No bone fish hooks are reported from hereabouts, though suggested by early writers.

Bone Beads and Tubes. While so abundant on Iroquoian sites, tubes and beads made of hollow bird or other animal bones, polished and cut in sections, are very rare here.

Draw Shaves, or Beaming Tools, made of bone, and probably used for removing the hair from skins, were made by splitting the bone of a deer's leg, leaving a sharp blade in the middle with the joints on either end as handles. The writer has seen none from this immediate region, but they are reported by Mr. M. R. Harrington. A number were obtained for the Museum by Mr. Ernst Volk in the Lenapé sites near Trenton, New Jersey. An implement, evidently made of the scapula of a deer, and perhaps used as a scraper, was found in a grave at Burial Ridge, Tottenville, Staten Island, by Mr. George H. Pepper.

Worked Teeth. Perforated teeth of the bear, wolf and other animals, so abundant on Iroquoian sites never seem to be found here. Beavers' teeth, cut and ground to an edge, occur, and may have been used as chisels, or primitive crooked knives, or both, as they were till recently by some of the eastern Canadian Algonkin. Other cut beaver teeth may have served as dice or counters in gaming.

Turtle Shell Cups. These are common, and consist merely of the bony carapace of the box turtle (*Tranene caroline*), scraped and cleaned inside, the ribs being cut away from the covering to finish the utensil for use.

Antler Implements. Deer antlers and fragments of antler, worked and unworked, occur in all shell heaps and pits. When whole antlers are found, they usually show at the base the marks of the axe or other implement used

to detach them from the skull. Cut antler prongs, prongs broken from the main shaft and others partly hollowed and sharpened show the process of manufacture of antler arrow points. These are characteristic of this area and are usually conical in shape, hollowed to receive the shaft, and with one or more barbs; not infrequently, however, they are diamond-shaped in cross section. The shaft fitted into the hollow socket as in the case of the conical bone arrow points. A large number were found in and among the bones of human skeletons in a grave at the Burial Ridge, Tottenville, Staten Island.

Cylinders, neatly cut and worked all over, or cylindrical tines made of deer antler only cut and rounded at the ends, are not infrequent, and were probably used as flaking tools in making and finishing arrow points by pressure. One broken cylinder or pin, found on the Bowman's Brook site, Mariner's Harbor, Staten Island, had a rounded, neatly carved head. This specimen, however, seems to be unique.

Pottery stamps, perhaps of antler or bone, but which may be of wood, seem to have been used, judging by the decorations of many pottery sherds. A pottery stamp, carved from antler, was found slightly east of this region, at Dosoris, Glen Cove, Long Island, by Mr. M. R. Harrington, and is now in the Museum collection.

Trade Articles.

In spite of the frequent mention by old writers of barter of European for Indian goods, the amount of trade material found is small indeed. While it is abundant in the Iroquoian area, all that has ever been found here consists of a few round-socketed iron tomahawks, iron hoes, brass or copper arrow points of various styles, a little porcelain, a few glass beads, Venetian and plain, and some old pipes, notably those stamped "R. Tippet" on the bowl. All these articles are very rare here, and for this no adequate explanation can be given.

Résumé.

This area was inhabited during historic times by the following tribes:[1]

A. The Lenni Lenapé, or Delaware, ranging from the Raritan River, including Staten Island, to Saugerties on the west bank of the Hudson.

[1] On the map (Fig. 18), these tribes are shown together with the Long Island and other neighboring tribes as indicated by Beauchamp in the map accompanying his "Aboriginal Occupation of New York," New York State Museum, Bulletin 32, Albany, 1900.

Raritan or Assanhican.
Hackensack.
Tappan.
Aquakanonk.
Haverstraw.

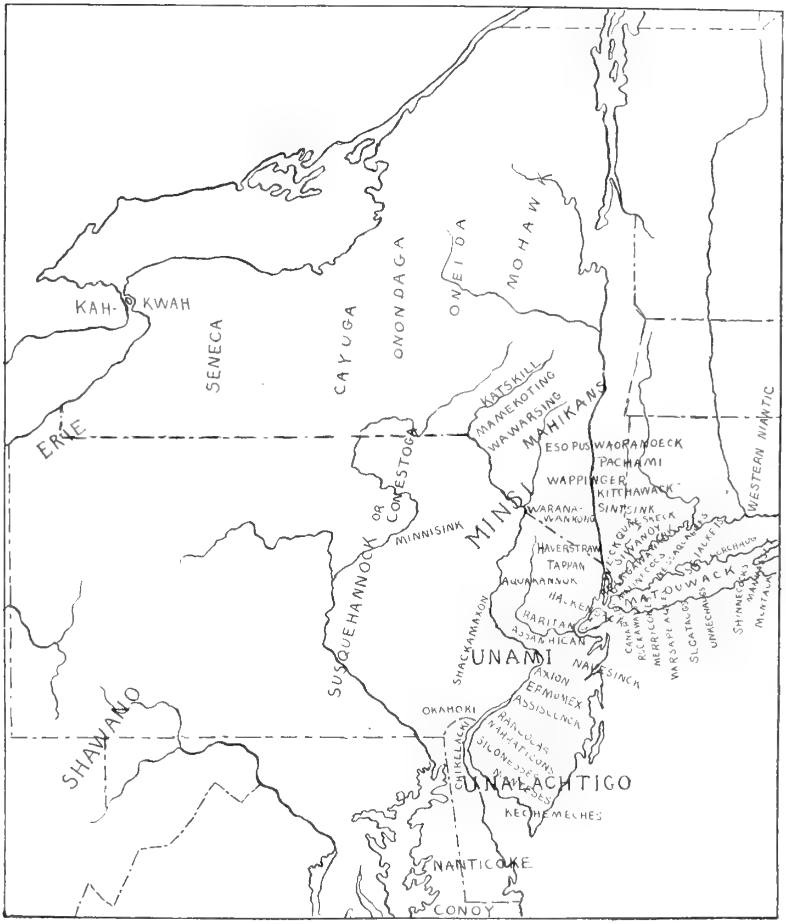


FIG. 18. MAP SHOWING THE LOCATION OF THE NEW YORK COASTAL ALGONKIN AND THEIR NEIGHBORS.

Waranawankong.

B. The Wappinger Confederacy ranging along the east bank of the Hudson, eastward to Connecticut, from Manhattan Island.

Rechgawawank or Manhattan.

Siwanoy.
Weckquaskeck.
Wappinger.

C. Montauk or Matouwack Confederacy.
Canarsie.

These tribes were surrounded on all sides by neighbors of the same stock, who differed somewhat in their language and culture. On the south and west, lay the Lenni Lenapé, or Delaware proper; on the north, the Manhattan, and on the east the New England tribes. Almost without exception, these natives were displaced early in the history of this country, and have been long since expatriated or exterminated. A very few mixed bloods may yet be found on Staten Island, Long Island and in Westchester County, but their percentage of Indian blood is extremely low.

The remains of aboriginal life now to be found, consist of shell heaps, occurring at every convenient point along the coast, on the rivers, and, more rarely, inland; shell, refuse, and fire pits; camp, village and burial sites; and rock and cave shelters. With one prominent exception.[1] few or no relics have been found in graves. The typical interment was of the flexed variety, but bone burials are not infrequent.

Dog skeletons complete and intact, bearing the appearance of having been laid out, are sometimes found buried in separate graves. Some writers have supposed that these individual dog burials are the remains of "white dog feasts" or kindred practices, because the Iroquois even up to the present day hold such ceremonies. The white dog is entirely cremated by the Iroquois, and so far as we have been able to find out, there is no record of such occurrences among the coastal Algonkin; hence, there seems no reason to attribute this custom to them since other Iroquois traits were so infrequent. It seems more probable that such burials are simply those of pet animals, interred as we to-day honor a faithful dog.

Occasionally, the skeletons of dogs and rarely of other animals have been found in graves associated with human bones. The finding of arrow-heads among the ribs of some of these, and other circumstances, seem to point to a practice of killing a favorite animal on the death of its owner to accompany or protect the spirit of its master on the journey to the hereafter.

From their appearance and position, many graves seem to indicate that the dead may sometimes have been buried under the lodge, especially in time of winter, when the ground outside was frozen too hard to permit grave digging. Others under the same circumstances seem to have been buried in refuse pits. The remains further indicate that "feasts of the dead," were

[1] Burial Ridge, Tottenville, Staten Island.

also held at the time of the interment, judging by the quantity of oyster shells and animal bones in and near the graves. Some graves have rows or layers of oyster shells, with the sharp cutting edge upward, placed above the bodies as if to prevent wild animals from disinterring and devouring the dead.

An interesting fact, brought to light by the rock-shelter work of Messrs. Schrabisch and Harrington in their explorations in New Jersey and Westchester County, New York, is that in the lowest and oldest refuse layers of these shelters pottery does not occur. It would be ill advised to infer from this that the earliest occupants were peoples of another culture from the surrounding village dwellers, as the other artifacts found are quite similar to the implements of the latter. Many reasons for this lack of pottery, such as the more easy transportation of vessels of bark or wood through the mountains and hills, suggest themselves, though they are more or less nullified by the presence of pottery in the upper layers. The upper layer, however, may have been made during the period when the natives were being displaced by Europeans and at the same time subjected to Iroquoian raids, when the villages would naturally be abandoned from time to time, for refuge among the cliffs and caves of the mountain fastnesses.

It has been suggested that the rock and cave shelters are remains of an older occupation by people with or without the same culture as the later known savages. The nature of the finds does not support this view, for the specimens obtained are often of as good workmanship as the best to be found in the villages and cemeteries of the latter, while pottery, on the other hand, occurs on the oldest known Algonkian sites. It seems most probable to the writer that, like the shell heaps, the rock and cave shelters form but a component part, or phase, of the local culture, perhaps a little specialized from usage and environment, but contemporary with the villages, shell heaps and cemeteries of the lowlands.

Mounds and earthworks do not occur in the region under consideration, nor does it appear that most of the Indian villages here were fortified, unless they were slightly stockaded. A number of instances of this are known historically, however, and a few earthworks occur just beyond this area.[1]

The remains found do not bear any appearance of very great geological antiquity. In a few instances, rock-shelters, shell heaps and village sites seem to possess a relative antiquity; but the oldest known remains, in every case, may be placed as Algonkian with considerable certainty. No paleoliths have been reported, and it would seem from the comparative lack of antiquity of the remains that the natives could not have lived in this region for many centuries before the advent of the whites. The accounts of con-

[1] An earthwork at Croton Point on the Hudson has been excavated by Mr. M. R. Harrington for the American Museum.

temporary writers prove conclusively that these archæological remains, if not those left by Indians found here by the early Dutch and English settlers, must have been from people of very similar culture. In culture, the local Indians were not as high as the Iroquois, nor perhaps as the Lenapé or Delaware proper from whom they sprang; but they compare very favorably with the New England tribes. Absence and scarcity of certain artifacts such as steatite vessels, the long stone pestle, the gouge, adze and plummet, and the abundance and character of bone and pottery articles show them to have been intermediate in character between the Lenapé on the south and west, and the New England tribes on the east and north; and consultations of the old European contemporaries show that this was the case linguistically as well as culturally. Examination of the remains also shows that the influence of the Lenapé on the west, and of the New England peoples on the east, was most strongly felt near their respective borders. Iroquoian influence was strong, as evinced by the pottery, and there is also documentary evidence to this effect. Finally, as is frequent throughout most of eastern North America, the archæological remains may be definitely placed as belonging to the native Indian tribes who held the country at the time of its discovery or to their immediate ancestors.

Historical Notes on the Indians of Manhattan.[1]

Historical references to the Indians who occupied this territory in the early days are very confusing and contradictory. There seems to be a great deal of trouble in the use of the word Manhattan. Van der Donck in 1633 classified the Indians of this section by language, and said, "Four distinct languages — namely Manhattan, Minqua, Savanos and Wappanoos"— are spoken by Indians. "With the Manhattans we include those who live in the neighboring places along the North River, on Long Island, and at the Neversinks."[2] It is probable that "it was.... this classification by dialect that led the Dutch to the adoption of the generic title of Manhattans as the name of the people among whom they made settlements."[3] De Laet wrote that "on the east side, on the mainland, dwell the Manhattans," and in 1632 Wassenaer adds that they are "a bad race of savages, who have always been unfriendly to our people" and that "on the west side are the Sanhikans, who are the deadly enemies of the Manhattans."[4] "When Hudson returned from his trip up the River which now

[1] First paragraph by James K. Finch.
[2] Wilson, Memorial History of N. Y., Vol. I, p. 34.
[3] Ibid., p. 49.
[4] Ibid., p. 34.

bears his name, he was attacked by Indians in birch or dug-out (?) canoes at the mouth of Spuyten Duyvil Creek. These Indians were a sub-tribe of the Wappingers or Wapanachki called the Reckgawawancs."[1] This name seems to have been given to the Indians who inhabited Manhattan Island, while the term Manhattans as already stated was a classification of dialect only. Ruttenber says that the Reckgawawancs were named after their chief Rechgawac;[2] and the name also seems to have been applied to part of the island for Riker says that,—"The Indians still [in 1669] laid claim to portions of the Harlem lands,....one of the tracts being their old and favorite haunt Rechewanis, or Montagne's Point. The chief claimant was Rechewack, the old Sachem and proprietor of Wickquaskeek, who, as far back as 1639, had been a party to the sale of Ranachqua and Kaxkeek."[3]

Not much is known of their habits and customs beyond what has been inferred from the relics to be seen in this exhibit, but Mr. Bolton writes:

"We are not without detailed description of our primeval predecessors upon the island of Manhattan, for the Hollanders recorded many of their impressions of aboriginal peculiarities. We may assume that they possessed the usual characteristics, the stolid demeanor, the crafty methods, and revengeful nature of the Indian, all of which were exhibited in their dealings with the White intruders. These local bands appear to have had, in addition, some particular local habits. They painted their faces with red, blue, and yellow pigments, to such a distortion of their features, that, as one sententious Dominie expressed it, 'They look like the devil himself.' Their dependence on supplies of game and fish caused their removal from one place to another, semi-annually, and we read of their removal to a summer 'hunting-ground' in Westchester, whence the band returned to 'Wickers Creek,' for the winter shelter, and to resume their occupation of oystering and fishing in the Harlem and Spuyten Duyvil Creek.

"As for dress, 'They go,' said Juet, 'in deerskins, loose well-dressed, some in mantles of feathers, and some in skins of divers sorts of good furres. They had red copper tobacco pipes, and other things of copper they doe weare about their neckes.'

"No copper objects have been found in upper Manhattan, probably their metallic stock was bartered away with the early colonists, for in 1625, De Laet described their use of 'Stone pipes for smoking tobacco.'

"As regards their food, the evident abundance and size of the local oyster shells shows that they possessed in them a ready source of subsistence. As soon as Hudson's ship reached the neighborhood of Greenwich, where the

[1] Ibid., p. 46.
[2] Ruttenber, op. cit., p. 78.
[3] History of Harlem, p. 287.

Indian Village Sappokanikan was located, the natives 'brought great store of very good oysters aboard, which we bought for trifles.' De Laet (1625) says, 'their food is maize, crushed fine and baked in cakes, with fish, birds and wild game.' Van der Donck and others wrote in 1649:

> Their fare, or food, is poor and gross, for they drink water, having no other beverage; they eat the flesh of all sorts of game that the country supplies, even badgers, dogs, eagles and similar trash, which Christians in no way regard; these they cook and use uncleansed and undressed.
>
> Moreover, all sorts of fish; likewise, snakes, frogs and such like, which they usually cook with the offals and entrails.
>
> They know also, how to preserve fish and meete for the winter, in order then to cook them with Indian meal.
>
> They make their bread, but of very indifferent quality, of maize, which they also cook whole, or broken in wooden mortars.
>
> The women likewise perform this labor, and make a apa or porridge called by some, Sapsis, by other, Duundare, which is their daily food, they mix this also thoroughly with little beans, of different colors, raised by themselves; this is esteemed by them rather as a dainty than as a daily dish.

"Their weapons were, of course, the usual aboriginal bow, arrow, spear, club and tomahawk, though but a few years later, they had acquired from the settlers enough fire-arms to become exceedingly expert in their use. 'Now, those residing near, or trading considerably with the Christians, make use of fire-locks and hatchets, which they obtain in barter. They are excessively fond of guns; spare no expense on them, and are so expert with them, that in this respect they excell many Christians.' Many of their discarded neolithic weapons have been found, and these exhibit a wide variety of material and workmanship, indicating considerable acquisitions from other tribes and localities. Their household utensils included 'mats and wooden dishes,' and Juet refers to their 'pots of earth to dresse their meats in,' and speaks also of the women bringing 'hempe.' The character of the grass mats which the women wove is to be seen in the imprints made with such material upon the outer surface of some of the local pottery. They also made the grass baskets, often referred to in early records, as 'napsas.' The pots of earth were the large earthenware vessels made by the Indian women, on the decorations of the rims and upper portions of which these poor creatures expended all their ingenuity and sense of art.

"Of these objects, there remain a number of interesting examples discovered in upper Manhattan, the most complete, and at the same time, most artistic, being the fine Iroquoian vessel discovered by Mr. W. L. Calver, on the south side of 214th Street, about 100 feet east of 10th Avenue, in the fall of 1906. The large vases found in broken condition in the cave at Cold Spring, are of the cruder and therefore, earlier design of the original

Algonkian inhabitants, who at a later period, probably by barter, and perhaps by inter-marriage, acquired or learned the art of Iroquoian design and decoration.

"Of the period during which the race occupied this locality, we can only make conjectures. The extent and character of the shell heaps at Cold Spring and the pits and burials at Seaman Avenue, certainly indicate a settlement of large numbers or of considerable age. The ceremonial pits at 212th Street and certain remains of aboriginal feasting, such as fish bones and oyster shells, appeared to exist at a level below the graves of the slaves of the settlers, buried at that place.

"While these conjectures may carry back the period of occupancy to antiquity, the tools and weapons are all of the modern order, and no objects of true paleolithic character have been discovered, so that we have as yet nothing definitely reaching back into the remote ages of the most primitive mankind, although on Hunt's Point in the Bronx, at no great distance away from our island, a very interesting rude ax and a hammer were discovered by Mr. Calver in a gravel-pit, near the old Hunt burying-ground."

Location of Archæological Remains on Manhattan Island.[1]

The first field work done on Manhattan Island is of very recent date. Doubtless many articles of Indian manufacture and evidences of Indian occupation were found as the city grew up from its first settlement at Fort Amsterdam, but of these specimens we have very few records. The first specimens found which have been preserved, to the knowledge of those now interested in the subject, were found in 1855, and consisted of a deposit of Indian arrow-points found in Harlem during excavation for a cellar on Avenue A, between 120th and 121st Streets. Some of these are spoken of by James Riker[2] as being in the author's cabinet. Riker also speaks of shell heaps near here.[3] The next specimens preserved were found at Kingsbridge Road (now Broadway) and 220th Street in 1886, and are in the John Neafie collection at the Museum. These consist of an arrow point and a few bits of pottery. The next work was begun in 1889 by Mr. W. L. Calver of this city, and has led to the discovery of much valuable material which has been preserved.[4]

[1] By James K. Finch.

[2] History of Harlem (1881), footnote, p. 137.

[3] Ibid., p. 366.

[4] In the Spring of 1890 Mr. Edward Hagaman Hall began his investigations and at about the same time Mr. Reginald P. Bolton entered the field of local research. In many instances these gentlemen and Mr. Calver collaborated with valuable results. In the preservation of the traces of Indian occupation of Manhattan Island the American Scenic and Historic Preservation Society (formed in 1895 under the presidency of the late Hon. Andrew H. Green, but now under that of Dr. George Frederick Kunz) has done much pioneer work. EDITOR.

The following account of the work is taken mainly from Mr. Calver's note-book:

In the autumn of the year 1889, while exploring the heights of Bloomingdale (now called Cathedral Heights) for any relics that might have remained from the Battle of Harlem, Mr. Calver discovered one arrow point at 118th Street, east of Ninth Avenue, and immediately afterwards a circular hammer-stone. On a later trip to the same locality, he found a small grooved axe or tomahawk.[1] In February, 1890, while hunting for Revolutionary relics in the vicinity of Fort Washington, he made a trip to the northern part of the Island in search of British regimental buttons, many of which were said to have been found in that vicinity. There he met an old acquaintance, Mr. John Pearce, a policeman then on duty there, by whom he was introduced to Mr. James McGuey, a youth residing in the vicinity of 198th Street and Kingsbridge Road. To Mr. Calver, Mr. McGuey presented several relics found by himself on camp sites and made an appointment to meet him early in March to explore for Indian remains. The same day, Mr. Pearce took Mr. Calver to be introduced to Mr. Thomas Reefe who resided near Kingsbridge Road and Isham Avenue, and, while crossing the orchard at Academy Street and Seaman Avenue, Mr. Calver saw that the ground was thickly strewn with shells which afterwards proved to be of Indian origin.

The first Sunday in March, Messrs. Calver and McGuey explored this part of the Island for Indian remains. At the junction of Academy Street and Prescott Avenue, they found an Indian potsherd whose importance Mr. McGuey seemed to realize, for, a week later, Mr. Calver met him again and was presented by him with a number of fragments of Indian ware. He assured Mr. Calver that he had found it by digging in an Indian graveyard. The two men dug again at this place, now known as "the Knoll," and found more pottery. They then went to Cold Spring, a point on the extreme northern end of the Island, and in a shell heap there they found more Indian work. Mr. Alexander C. Chenoweth, an engineer, then on the Croton Aqueduct, hearing of these discoveries, obtained a permit from the property owners and began to explore "the Knoll" for Indian remains. Having finished here, he went to Cold Spring and made some further discoveries. All his specimens were purchased in 1894 by the Museum, and some of them are now on exhibition.

Since this time, several interesting relics have been found and, as the work of grading streets and other excavation at this part of the Island are carried on, more relics will probably come to light. An account of the recent finds will be found in another part of this Guide, the time of this writing having been 1904.

[1] The writer found an arrowhead on South Field, in front of Columbia University Library, on September 30, 1904.

The only Indian remains left on the Island, so far as known to the writer, are situated at the extreme northern end at Inwood and Cold Spring. They consist of the co-called shell heaps or refuse piles from Indian camps, and three rock-shelters at Cold Spring. But we have evidence to show that this was not the only part of the Island occupied by the Indians. Mrs. Lamb [1] says that the Dutch found a large shell heap on the west shore of Fresh Water pond, a small pond, mostly swamp, which was bounded by the present Bowery, Elm, Canal and Pearl Streets, and which they named Kalch-Hook or shell-point. In course of time, this was abbreviated to Kalch or Collect and was applied to the pond itself.[2] This shell heap must have been the accumulation of quite a village, for Mrs. Jno. K. Van Rensellaer [3] speaks of a castle called Catiemuts overlooking a small pond near Canal Street, and says that the neighborhood was called Shell Point. Hemstreet refers to the same castle as being on a hill "close by the present Chatham Square," and says that it had once been an "Indian lookout." [4] Excavations at Pearl Street are said to have reached old shell banks. "The Memorial History of New York" [5] says that a hill near Chatham Square was called Warpoes, which meant literally a "small hill." [6] According to the same authority, "Corlear's Hoeck was called Naig-ia-nac, literally 'sand-lands.' It may, however, have been the name of the Indian village which stood there, and was in temporary occupation." This is the only reference we have to this village, but there are references to another on the lower end of the Island. Janvier [7] says that there was an Indian settlement as late as 1661 at Sappokanican near the present Gansevoort Market. According to Judge Benson,[8] Sapokanican was the Indian name for the point afterwards known as Greenwich. "In the Dutch records references are made to the Indian village of Sappokanican; and this name....was applied for more than a century to the region which came to be known as Greenwich in the later, English, times. The Indian village probably was near the site of the present Gansevoort Market; but the name seems to have been applied to the whole region lying between the North River and the stream called the Manetta Water or Bestavaar's Kill." [9] Benton says that the name of the

[1] History of New York City, p. 36.

[2] Mr. Edward Hagaman Hall, however, derives the name from "Kolk" or "Kolch" a word still in use in Holland and applied to portions of a canal or inclosure of water. The word also means "pit hole", which aptly describes the Collect Pond.

EDITOR.

[3] Goede-Vrouw of Manahata, p. 39.

[4] Hemstreet, Nooks and Corners of Old New York, p. 46.

[5] Bulletin, N. Y. State Museum, Vol. 7, No. 32, p. 107, Feb., 1900.

[6] James G. Wilson, op. cit., p. 52.

[7] Evolution of New York.

[8] N. Y. Historical Society Collection, S. II, Vol. II, Pt. I, p. 84, 1848.

[9] Thos. A. Janvier, In Old New York, pp. 85–86.

village was Lapinican.[1] Going back to the old Dutch records might lead to finding the actual names and other data regarding these places.

Most of the specimens found on Manhattan Island, as already stated, come from the northern part. We have a few from the central portion, however. There are the arrow-heads spoken of by Riker, and in Webster Free Library there is a fine specimen of a grooved stone axe found at 77th Street and Avenue B. Mr. Calver has found an arrow-head at 81st Street and Hudson River and specimens from the site of Columbia College have been recorded.

Doubtless the northern part of the Island was inhabited for the longer period; but it is probable that all along the shore, wherever one of the many springs or small brooks, shown on old maps, emptied into the Hudson or East River, there were small, temporary Indian camps. It is likely that these camps were used only in summer, while the primitive occupant of Manhattan retreated to the more protected part of the Island, as at Inwood and Cold Spring, during the winter. Or it may be possible that, as Ruttenber[2] states, the villages on Manhattan Island were only occupied when the Indians were on hunting and fishing excursions, while their permanent villages were on the mainland. Bolton,[3] however, says their principal settlement was on Manhattan Island.

Fort Washington Point. There is a small deposit of shells, on the southern edge of the point, in which the writer found some small pieces of pottery and a few flint chips, thus proving its Indian origin. This was probably a summer camp, as it was too exposed for winter use.

The Knoll. "The Knoll" was the name applied to a small rise of land, at the southwest corner of Dyckman Street and Sherman Avenue, which ran out into Sherman Creek from the eastern edge of the hill at that place. As already stated, Messrs. Calver and McGuey found potsherds here; then Mr. Chenoweth obtained permission of the property owners to make excavations. He found numerous fragments of arrow points and pottery in some refuse deposits from an Indian camp and also uncovered what were thought to have been "paved fireplaces." The newspapers of the time had accounts of the finds, with pictures of the pottery and other objects found.[4] Mr. Chenoweth also uncovered a number of skeletons. It is stated that these graves were marked with rough headstones, and there are pieces of a coffin from here in the Terry collection in the American Museum, as are also a number of lead buttons found with one interment. Everything seems

[1] New York, p. 26.
[2] Indian Tribes of Hudson's River, p. 78.
[3] History of Westchester County, p. 25.
[4] New York Herald, January 14, 1894; also Illustrated American, September 19, 1901.

to point to these as being burials of early settlers, but Mr. Chenoweth holds that they are Indian. Several of the skeletons have been preserved in the Museum. A parallel condition to this at the Knoll was found at 211th Street and will be spoken of later. The Knoll site had undoubtedly been an ancient Indian camp. Probably Sherman Creek was open up to this point to Indian canoes.

Cold Spring. Cold Spring is situated at the extreme northern end of Manhattan Island on the southern shore of Spuyten Duyvil Creek. The Indian remains consist of three rock-shelters and three refuse heaps. The rock-shelter is a formation where the overhanging rocks form a small cave or shelter which the Indians used as a dwelling place. All their rubbish, such as oyster shells, broken pottery and broken arrow heads, were dumped near by, forming the so-called shell heaps. Messrs. Calver and McGuey explored the shell heaps; but Mr. Chenoweth was the first to suspect the existence of the shelters. There is only one which is likely to have been used as a dwelling place, the others being places where food was stored or shelters for fires used in cooking. These shelters face east, and are at the foot of the hill (formerly called Cock Hill) which forms the most northern part of Manhattan Island. The largest one was formed by several of the rocks breaking off the cliffs above and falling in such a manner that, by digging out some of the earth from beneath them, the Indians could make a small shelter. Probably it was occupied by one family, while the others lived in bark wigwams near by.[1] Another of the shelters is simply an excavation under the end of a huge fragment which also dropped from the cliffs above, and the third is a large crevice in the foot of these cliffs. When Mr. Chenoweth first explored them, all these shelters were completely filled with earth which had gradually worked its way in since their occupation, and much credit is due him for suspecting their presence. In them he found fragments of pottery and stone implements, together with the bones of turkey and deer. The largest of the refuse heaps is situated on a rise directly in front of these shelters. It consists of a layer of shells, in places several inches thick, found under a layer of fine loam, a black earth which has been deposited since the shells were scattered over the original sandy yellow soil. The sheltered position of this place made it an especially desirable camp site. The hills to the south and west formed a protection to the camp from winds, and by Spuyten Duyvil Creek access could be had to either Hudson or East River; while the Cold Spring, from which the place takes its name, furnished an abundant supply of fresh water.

[1] Memorial History of New York, Vol. I, p. 33, for picture of houses, and p. 39 for description.

Inwood Station Site. At the foot of Dyckman Street and Hudson River, there existed a large deposit of shells, most of which were removed when the rocks on which they lay were blasted away for grading the street. A few arrow points and bits of pottery, as well as several Revolutionary objects, were found here. Part of the deposit is still left on the northern shore of the small bay just below Inwood station. There are photographs of this deposit in the Museum.

Harlem Ship Canal. Formerly at 220th Street and Kingsbridge Road was a large deposit of shells on the westerly side of the road. This was destroyed when the ship canal was put through. As with the Inwood Station site, no systematic examination of this place was ever made. Mr. John Neafie found some potsherds here in 1886, and Mr. Chenoweth also has some potsherds from here.[1] Mr. Calver says that this was a large deposit, and that the peculiar thing about it was that the shells were so wedged and packed together that a pick would hardly penetrate them. They lay on the bare rock surface in cracks in the rock.

Harlem River Deposit. Mr. Calver says, "Extending from 209th Street to 211th Street on the west bank of the Harlem River and almost on a line with Ninth Avenue was another large deposit of oyster shells lying just beneath the top soil of the field. These shells had nearly all been disturbed by the plow and are interesting only for their color, which was red. Pieces of horn of deer and split bones of the same animal were common among the shells; but, in spite of the apparent antiquity of the deposit, there were, even in the lowest strata of it, some small fragments of glass which proved that either the whole mass had been disturbed or else the shells had been left during the historic period. There are several stone sinkers and hammerstones from this spot in Mr. Calver's collection and at the Museum.

Isham's Garden. This is a large garden about on the line of Isham Street and Seaman Avenue. The soil is white with small fragments of shells. A number of arrow points, flint chips, hammerstones, sinkers and a few bits of pottery have been found here. Mr. Calver has found several shell pockets with small deposits of pottery, etc., on the hill to the south of this garden.

Academy Street Garden. This is a small garden between Academy and Hawthorne Streets, running through from Seaman Avenue to Cooper Street. It was a British camp site during the Revolution, and a number of buttons, gun-flints and bullets have been found there as well as numerous Indian remains. It seems to have been the workshop for a red jasper-like stone of which numerous chips but no finished implements have been found. The shells at this point were first noticed by Mr. Calver in 1890. They may not all be of Indian origin, as some may be due to soldiers.

[1] John Neafie collection, 20–2558; Chenoweth, 20–3498.

Dog Burials found in 1895. In January, 1895, Mr. Calver found two interesting "dog burials." The first burial was unearthed at the summit of a ridge of soft earth at 209th Street, near the Harlem River. The ridge, which was about twelve feet high, had been partly cut away for the grading of Ninth Avenue. It was at the highest part of the hillock that a pocket of oyster and clam shells was noticed, from which a few fragments of Indian pottery which lay on the face of the bank had evidently fallen. The shells, upon inspection, were found to have served as a covering for the skeleton of a dog or wolf. Another burial was found on May 18th within fifty yards of the first burial. It had been covered with shells just as the first one, but had been disturbed by workmen. Mr. Calver says: "The two canine burials were situated at a point just without the borders of the Harlem River shell heap and were distinct from it. The shells were found to be matched, hence it was concluded that they were thrown in unopened or eaten on the spot. As the skeletons were intact and the bones uninjured, all probability of the animals having been eaten is disposed of." These burials are common in this vicinity. No satisfactory explanation of them has been given; but Mr. Calver thinks they were for some religious purpose, and suggests a relation to the "White Dog Feast" of the Onondaga of this State.[1] It is certain that the pockets were in many cases used as fireplaces.

Shell Pockets at 211th Street. In March, 1903, there was considerable excitement over the reported discovery of an Indian graveyard at 211th Street.[2] The graveyard proved to have been that of some slaves, and was situated on the western end of the rise between 210th and 211 Streets, on the eastern end of which is the old Neagle Burying Ground. This discovery was interesting because under the negro graves several shell pockets of undoubted Indian origin came to light. The workmen, in grading Tenth Avenue, cut into this hill to obtain material for filling, and uncovered the graves and pockets. It seems almost certain that the deposits were made some time ago; then the wind blew the sand over the deposits to a depth of four or five feet, and negroes later used this place as a burial ground. In support of this theory is the fact that the pockets were four or five feet under the surface, that the soil above showed no signs of having been disturbed, and that this rise is put down on the Government maps of this section as a sand dune.[3] During the summer of 1904, Mr. Calver with Messrs. Hall and Bolton uncovered nine more pockets to the southwest of the graveyard.[4] These pockets all seem to have been of the same period as the others, and

[1] N. Y. Herald, May 26, 1895.
[2] Evening Telegram, March 14, 1903.
[3] New York Geologic Folio.
[4] New York Tribune, Oct. 30, 1904, and New York Sun, Dec. 14, 1904.

all appear to have been on the original ground surface, although those farther up the hill were some four feet under the present surface. In one of these pockets, was found the complete skeleton of a dog[1]; in another, a turtle shell; two others contained complete snake skeletons; while a fifth held the fragments of a small pottery vessel. The pockets were small, being about three feet in diameter and of equal depth, showing no signs of having first been used as fire places and then filled up, though charcoal was scattered among the shells. Almost all the relics from Van Cortlandt Park were found by Mr. James in pockets similar to these.

During Indian troubles in 1675, the Wickquaskeeks at Ann's Hook, now Pelham Neck were told "to remove within a fortnight to their usual winter quarters within Hellgate upon this island." Riker says, "This winter retreat was either the woodlands between Harlem Plains and Kingsbridge, at that date still claimed by these Indians as hunting grounds, or Rechawanes and adjoining lands on the Bay of Hellgate, as the words 'within Hellgate' would strictly mean, and which, by the immense shell-beds found there formerly, is proved to have been a favorite Indian resort."[2] A little later the Indians asked to be allowed to return to their maize lands on Manhattan Island and the Governor said that they, "if they desire it, be admitted with their wives and children, to plant upon this Island, but nowhere else, if they remove; and that it be upon the north point of the Island near Spuyten Duyvel."[3]

Mrs. Mary A. Bolton Post, in writing to the editor of "The Evening Post," June 19th of the year of the opening of the Harlem Ship Canal (1895), speaks of some Indians who were allowed to camp on the south side of Spuyten Duyvil Creek on the Bolton property in 1817. Ruttenber says that the Reckgawawanos had their principal village at Yonkers, but that on Berrien's Neck (Spuyten Duyvil Hill) was situated their castle or fort called Nipinichsen. This fort was protected by a strong stockade and commanded the romantic scenery of the Papirinimen, or Spuyten Duyvil Creek, and the Mahicanituk (Hudson River), the junction of which was called the Shorackappock. It was from this castle that the Indians came who attacked Hudson on his retu n down the river.[4] Some small shell deposits occur on Spuyten Duyvil Hill, but as yet this "castile" has not been definitely located. The village site at Yonkers, according to Mr. James, is now covered by buildings; but several relics found near the site years ago are now in the Manor Hall at that place (1904).

[1] All that could be saved of this skeleton has been presented to the Museum by Mr. Edward Hagaman Hall.

[2] History of Harlem, p. 366.

[3] Ibid., p. 369.

[4] Ruttenber, pp. 77–78.

Judging from these references, we might conclude that the territory occupied by the tribe commonly known as Manhattans included Manhattan Island and that part of the mainland which is west of the Bronx River north to Yonkers, and that these Indians were a sub-tribe of the Wappinger division of the Mahican.

Indian Burials.

Indian Burials. Notwithstanding all the efforts of various collectors, the first Indian burials to be discovered on the Island were due to the activities of Messrs. Bolton and Calver in 1904. The improvement of Seaman Avenue, Upper Manhattan, at that time, uncovered many relics of the long extinct Indian inhabitants among which Mr. Bolton saw unmistakable signs of Indian graves. To quote from this gentleman: "It thus became evident that there were human interments in the vicinity, and in August, 1907, the first burial was discovered under a shell pit in Corbett's garden. The grading process had been extended only about eighteen inches below the sod, but had sufficed to destroy the jaw of the skeleton which extended upwards, as did also the foot bones. The bones lay in and upon a close mass of oyster shells, some of which were unopened, the skeleton reclined on its right side, facing west. The arms were flexed and crossed, the knees bent and the head thrown back. No traces of weapons were found, nor were there any other objects found, save a fragment of an animal bone.

"The location and position led to further exploration, which, early in 1908, led to still more interesting discoveries. Sunday, March 22nd, being the first day in the field for exploration for the season for 1908, W. L. Calver and the writer met at Seaman Avenue and Hawthorne Street, Manhattan, to discuss plans for further excavations on this Indian village site. The rains of the winter 1907–8 had washed the west bank where the layer of oyster shells and black dirt lay along the hill, and a patch of red burnt earth was observed, which on digging out, disclosed a fireplace, evidently of the period of the Revolution, having some large burnt stones, ashes, wood charcoal, brick, broken rum bottles, a wine glass nearly complete, a large open clasp-knife with bone handle, a hoop-iron pot-hook, various forged head nails and a curious folding corkscrew. Gold buttons of Revolutionary pattern and an officer's silver button of the Royal Mariners, together with pewter buttons of the 17th Regiment disclosed who had occupied the spot.

"At one part of this fireplace, we came upon a pocket of oyster shells, evidently Indian, about two feet deep, and on removing some of these, had the good fortune to uncover a human thigh-bone. We worked carefully

into the shells and under the pocket, gradually disclosing the complete remains of a full-grown man (Fig. 19) lying on its right side, feet to the north, head facing east, knees doubled up, the left arm extended down through the thighs. The feet had been within the area of the hole in which the Revolutionary fireplace had been made, and only one or two foot bones were found. At a later period other foot bones were found on the opposite side of the Revolutionary fireplace, evidently having been displaced in its construction. The right arm was flexed, and the hand was under the head, the latter was

FIG. 19. INDIAN BURIAL, MANHATTAN.

intact and every tooth was in place. Shells had been packed over the body, and some around it. We were much puzzled by a number of human bones, lying compactly together by the skeleton, in a position that would have been in its lap had it been upright.

"We removed the skull, covered the remains, and on Sunday, March 29th, renewed the work. We went carefully to work upon the cluster of mixed bones in front of the large skeleton, and soon found them to be rather compactly arranged in a rectangular form about 14 by 26 inches, the long bones parallel. The vertebræ abruptly ended parallel with the head of the larger skeleton, and after working some time, we found a skull placed below, beneath the pile of bones in a vertical position, facing north, the

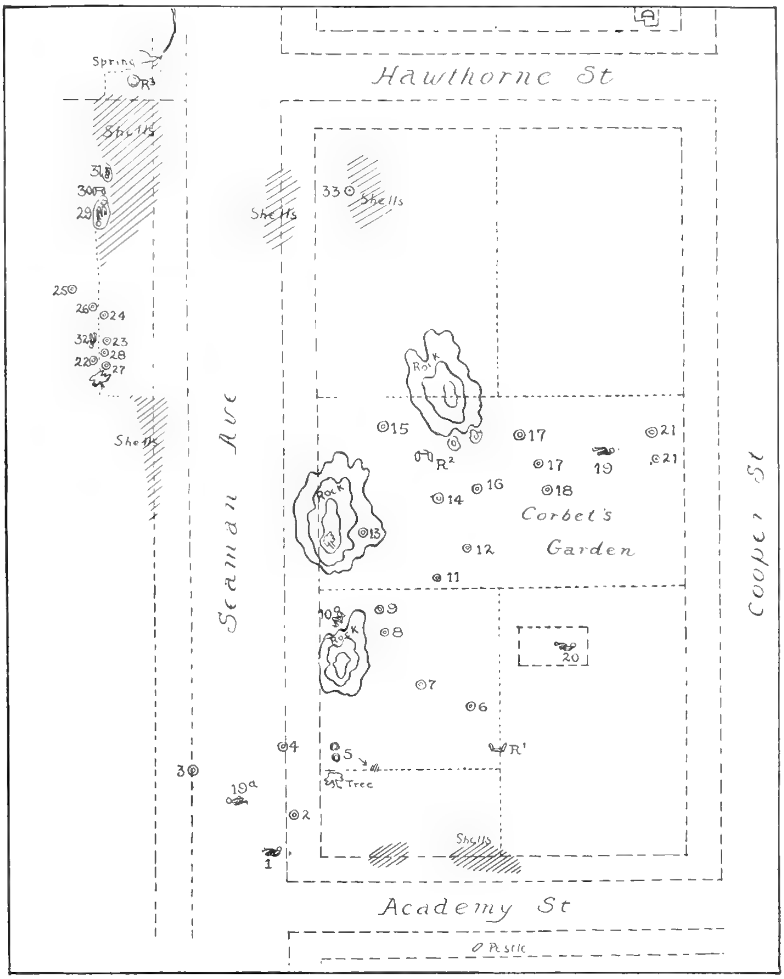


FIG. 20. LOCATION OF BURIALS, PITS AND SHELL-BEDS NEAR INWOOD

1. Human remains. 2. Shell pit, deer antler. 3. Shell pit. 4. Shell pit, pottery. 5. Shell pits. 6. Shell pit, sturgeon below. 7. Shell pit, sturgeon scales. 8, 9. Shell pits. 10. Human remains. 11. Fire pit. 12. Shell pit. 13. Dog burial, puppy. 14. Shell pit. 15. Part of a jar. 16. Shell pit, fish and meat bones. 17. Shell pits. 18. Two dogs in shell pit. 19. Human skeleton, 1907. 19a. Female skeleton, 1908. 20. Human remains when house was built. 21. Small fire pits, Revolutionary. 22. Large shell pit. 23. Large shell pit. 24. Shell pit. 25. Dog burial. 26, 27, 28. Shell pits. 29. Two human skeletons, male and female. 30. Revolutionary fireplace "Royal Mariners" and "17th." 31. Skeleton and infant, female. 32. Skeleton (Chenoweth, 1908). 33. Revolutionary fireplace, 71st, officers' buttons. D. Dyckman dwelling. R^1, R^2. Revolutionary fireplaces. R^3. Revolutionary well.

lower jaw of which was disengaged, and was placed sideways in front of the face. The back of the skull was broken in, and was black with marks of burning. The lower jaw was burned, and some of the teeth split by fire. The arm and leg bones were charred at the joints. Inside the skull was a burned toe bone. Some oyster shells were among the charred remains.

"A significant fact was that the right arm bones of the large skeleton were below the pile of burned bones. This feature, and the compact arrangement of the latter within the space in front of and at the same level as the large skeleton, seem to point strongly towards an intentional arrangement of these bones, in front of the large corpse and to indicate the simultaneous burial of the two bodies. On examination, the large skeleton proved to be that of an adult male, and the dismembered remains those of a female of about 35 years of age. No implements were found with the remains, but a part of a stone pestle and a rude celt lay under the sod among the oysters above the large skeleton.

"On Sunday, June 14, 1908, another burial was found about 20 feet north of the above. This burial consisted of an adult skeleton doubled up and its back much curved, and was apparently that of a female of mature age. Between the knees, the remains of a small infant were laid, the skull of the latter being fragmentary. The right hand of the adult was below the infant and the left hand around the throat. The skull was intact and had nearly all the teeth. One finger bone had grown together at the joint in a crooked position apparently due to disease. On lifting the ribs of the right side, an arrow-head of flint fell out between the fourth and fifth bones. These skeletons lay about two and a half feet below the grass, and a pocket of oyster shells was over the head. The woman's remains lay within a space about 31 inches long by 50 inches wide, flat in the hard red sand bed facing east.

"Shortly after these remains were discovered, Mr. Chenoweth extended the excavation previously made by the explorers at the side of a large oyster shell pit in the same bank of sand, and uncovered a male skeleton of which he preserved the skull. Some small fragments of the skeleton were afterwards found by the writer on this spot. Contractors for the sewer in Seaman Avenue also uncovered the remains of a young female close to the position of several of the shell pits previously described.

"These interments have some curious features. The position of the remains facing east, sometimes west, the absence of weapons or other objects and the oyster shells packed with or above them are subjects for interesting discussion on which future finds may throw much light, as also upon the peculiar double burial and the burnt state of the female remains."

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. October, 1903. *Price, 10 cents.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRDS' NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted,* February, 1905. *Price, 10 cents.*

No. 15.— PRIMITIVE ART. July, 1904. *Price, 15 cents.*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price, 15 cents.*

(Reprinted from The American Museum Journal.)

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1905. *Price, 15 cents.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Price, 15 cents.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price, 15 cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Price, 10 cents.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price, 15 cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Price, 10 cents.*

(Published as a separate series.)

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price, 10 cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Price, 15 cents.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price, 10 cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Price, 15 cents.*

No. 28.— THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price. 15 cents.*

No. 29.— THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909. *Price, 10 cents.*

The American Museum Journal

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY.

For Sale at the Museum.

(*Issued as supplements to The American Museum Journal.*)

No 1.— THE BIRD ROCK GROUP. By F. M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price,* 10 *cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. SMITH, Assistant Curator of Archæology. December, 1901. *Price,* 10 *cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph. D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By LOUIS P. GRATACAP, A. M., Curator of Mineralogy. February, 1902. *Revised edition,* May, 1904. *Price,* 10 *cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. ALLEN, Ph. D. Curator of Mammalogy and Ornithology. March, 1902. *Revised edition,* February, 1904. *Price,* 10 *cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By GEORGE H. PEPPER, Assistant in Anthropology. April, 1902. *Second edition,* May, 1909. *Price,* 10 *cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. May, 1902. *Price,* 15 *cents.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By GEORGE H. SHERWOOD, A. M., Assistant Curator. November, 1902. *Price,* 10 *cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition,* May, 1905. *Price,* 10 *cents.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. February, 1903. *Price,* 10 *cents.*

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price,* 10 *cents.*

(*Continued on page 3 of cover.*)

AMERICAN MUSEUM OF NATURAL HISTORY

Stokes Paintings represent-ing Greenland Eskimo

GUIDE LEAFLET NO. 30

NOVEMBER, 1909

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members	$ 10	Fellows	$ 500
Sustaining Members (Annual)	25	Patrons	1000
Life Members	100	Benefactors (Gift or bequest)	50.000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year.

* Deceased

The Stokes Paintings Representing Greenland Eskimo

A DESCRIPTION OF THE

MURAL DECORATIONS OF THE ESKIMO HALL

GIVEN TO THE

American Museum of Natural History

BY

ARTHUR CURTISS JAMES

No. 30

OF THE

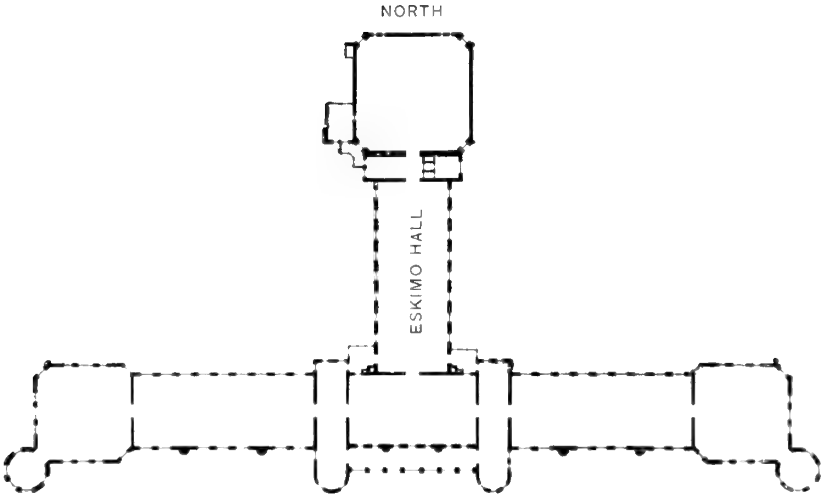
GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. November, 1909



Floor plan of the ground floor of the Museum, showing the location of the Eskimo Hall, where are displayed the Stokes paintings presented by Mr. Arthur Curtiss James.

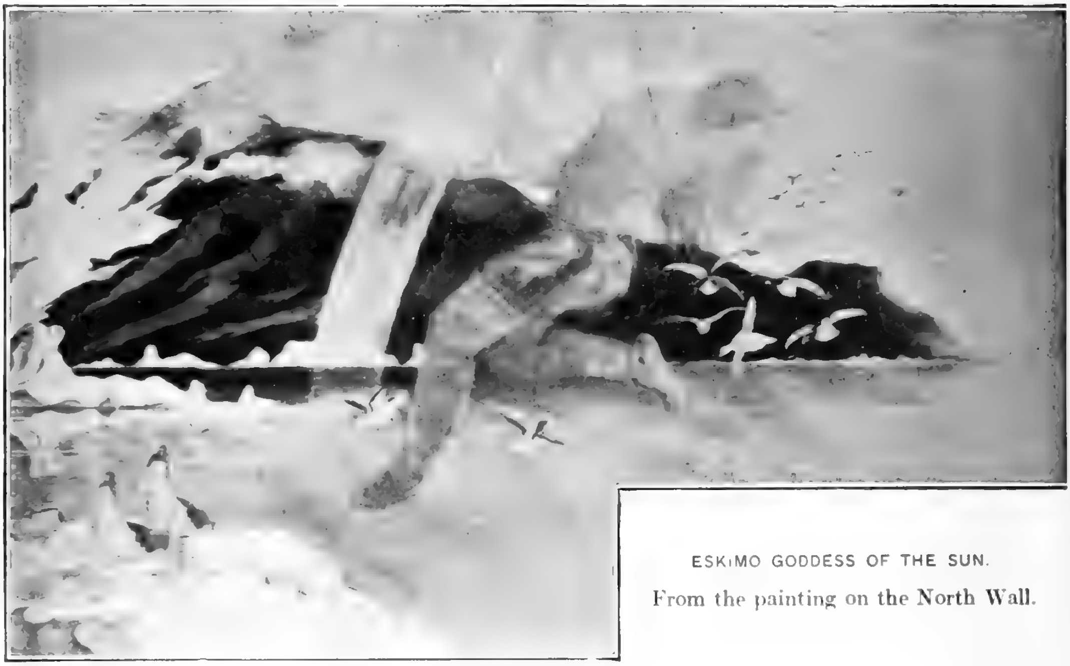
THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO.

THE mural decorations at the northern end of the Eskimo Hall have been painted by Mr. Frank Wilbert Stokes, an artist, who, as member of the Peary Relief Expedition of 1892 and of the Peary North Greenland Expedition of 1893 and 1894, has made careful study of the Eskimo people and their frozen country. The Museum is indebted for these paintings to Mr. Arthur Curtiss James, one of the Trustees.

Ranged about the hall below are the weapons, the articles of dress, the boats, the sleds, while above them in this painted frieze these same objects are seen put to use in the daily activities of the Eskimo, revealing his adaptation to an environment of months' long days and nights among glaciers and icebergs. The combination of the scientific exhibits below and the artist's work above, brings home to the observer not only the ethnological facts involved, but also other facts, such as the austerity of Eskimo life, its enforced simplicity and the limitations set upon civilization for the people of the Arctics. Much of the interest of these pictures rests in the fact that many of the scenes represent localities actually visited by the artist. Mr. Stokes established his studio at Bowdoin Bay, 77° 44′ N. latitude, and worked there during fourteen months, with the primitive life of the Eskimo and the glowing colors of the northern land under constant observation. As William Walton has said in an article in Scribner's Magazine for February, 1909, Mr. Stokes has here succeeded, despite the inadequacy of pigments, in well suggesting "the utmost splendor of light that blazes in the Polar skies and glows in the Polar, translucent ice."

The North Wall.

The largest picture of the series — in full view from the main foyer of the Museum — is a continuous panorama sixty feet long. It is intense and realistic in its coloring. In the center the glow of a midnight sun illuminates promontories and sea, toward the right this brilliant color gradually fades to the gray and purple of the twilight that precedes the long Arctic night, while toward the left it changes to the white lights and deep blue shadows of that other twilight that foretells the approach of the long Arctic day.



ESKIMO GODDESS OF THE SUN.

From the painting on the North Wall.

Against the vivid gold and red of the center of the painting is portrayed the artist's conception of the Eskimo myth of the "Sun and the Moon." There is presented a giant mirage of two figures in full pursuit through the air. These figures are Ahn-ing-ah-neh, a hunter, typifying the moon and ushering in the long winter, and Sukh-eh-nukh, standing for the sun, a goddess accompanied by summer and plenty. Ahn-ing-ah-neh is dressed in winter garb and is driving his team of dogs. The lower part of the figure, like the dogs and sledge, are shadowy in the painting, but the upper part reaching forward in the chase, the head and the right arm with its lashing whip, stand out strong and dark as the forward part of a night cloud that sweeps over the glacier-covered heights. Sukh-eh-nukh is represented by a figure uncovered to the waist (the Eskimo, both men and women, occasionally strip off the upper garments in the summer sun). She carries in her right hand an Eskimo lamp, shown as a sun-dog or parhelion such as is often seen near the horizon at sunrise and sunset in the Arctics. She is a part of a cumulus summer

ESKIMO CONCEPTION OF THE MOON A HUNTER IN PURSUIT OF THE SUN

Copyright 1908 by Frank Wilbert Stokes. Courtesy of Scribner's Magazine.

cloud that floats near her head. Summer birds are about her, a long line following from the far away horizon. Two fulmar gulls are flying in front of her, and two harp seals are crying to her, the "Mother of the Seals," from floating ice below, where also little Arctic puffins are ranged in military line.

The story of the pursuit of the sun by the moon is a legend widely spread among the Eskimo people. The North Greenland Eskimo believe, as do all other Innuit from Alaska to Labrador and Baffin Land, that the sun was originally a woman, Sukh-eh-nukh, who in order to escape the unfilial love of her brother, Ahn-ing-ah-neh, fled into the heavens bearing a lighted torch. The brother also carrying a torch pursued her and was transformed into the moon. It is believed that the moon is forever in love with the sun and seeks ever to overtake her, but that since his torch chanced to be a poor one and he is frequently compelled to return to earth to relight it, the sun is enabled to keep well in

advance. According to the myth, disaster would come if he should succeed in catching her, for with his embrace would come the end of all things.

This legend of the sun and the moon has many variations among the Eskimo people and is sometimes termed the Sedna Cycle, Sedna also signifying the sun. It is possible that we have here not only an allegory of the great Arctic day and night, but also the proof that there has taken root in Eskimo imagination the idea of man's search after the unattainable.

Copyright 1908 by Frank Wilbert Stokes.

POLAR BEAR AT BAY.

From the painting on the North Wall.

The right portion of the painting, realistic in the extreme, represents the twilight before the approach of the long night, the dramatic interest resting in an encounter between an Eskimo hunter and a polar bear. The hunter has left his sledge and, accompanied by his team, has followed in the chase. He has used his arrows and is now near enough to give a thrust with his lance, the bear's attention being held by the dogs.

That part of the painting at the extreme left tells the Eskimo's method of stalking prey. In the foreground on an ice-floe a hunter, harpoon in hand, is crawling slowly toward two ring seals, which lie basking in the

sun near their hole. Eskimo hunters have great skill in giving decoy sounds. They can make cautious approach to gulls by waving a gull's wing in the air, while whistling the bird's notes; they can allay the suspicions of seals by lying flat on the ice and waving a foot in imitation of a seal's head, while giving the characteristic calls of the seals. Beyond the seal hunter in the distance rises above the ice of the glacier, a bell-shaped elevation of land which the Eskimo knows as a "nunatak." Still farther to the left towers an iceberg, while over all is the dawning light of the summer that is being ushered in by Sukh-eh-nukh, the sun goddess.

ESKIMO STALKING THE SEAL.

From the Painting on the North Wall.

The East Wall.

The first or northern panel — An Innuit Encampment in Late Autumn.

Pictures of actual events in Eskimo life are continued on the east and west sides of the hall, the unity of the compositions being gained by making the sky line in the east and west panels the same as that of the

painting on the north wall. The three panels on the east wall continue pictures of Eskimo life as it goes on during the Arctic night.

The first of the panels gives a view of Inglefield Gulf, which by November is well frozen over. In the foreground to the right an Innuit (Memkashoo) is cutting up pieces of meat and feeding his team after a hunting trip. The sledge lies to the left, and just beyond is an Innuit woman with her babe carried on her back in a pouch. Such a pouch is made of fox skin and is a part of the hooded upper garment. The head and shoulders of the child are covered by soft fox skin, but the rest of its body lies naked against the mother's bare back and so is kept warm. The child is secured in the pouch by a sinew which passes around its body and around the upper part of the mother's waist.

A little Innuit boy stands by his mother, watching his playmate, an Eskimo puppy. Immediately to the right is the stone-built entrance of the igloo, or winter residence, which, partly covered with snow, is itself seen directly behind the figures. The seal-entrail window of the igloo reveals a pale light from the lamp within, a lamp which must serve the purposes of lighting, heating, cooking and drying for the whole family.

Beyond in the middle distance to the left is a bay, its shore covered with snow which is about three inches in depth at this season. Beyond the bay is a long low promontory stretching into the sea, a November sea, completely frozen over and with an iceberg frozen into it. The stars are brilliant in the sky, while mountain, sea and shore are enshrouded in rich orange light from a sun that is gradually receding.

The Central Panel — Walrus Hunting in February.

The east central panel represents a February scene on the ice of Baffin Bay, which is never completely frozen over. The flaming colors of the Aurora Borealis fill the sky and are reflected by the ice. In their weird light is made visible the attack of an Innuit hunter upon a large walrus, one of a group of three in the central foreground of the picture. In the immediate foreground to the right a bull walrus is just emerging from the water. There is no look of fear in the animal's dog-like eye, since he has not yet caught sight of the hunter.

In the Arctics the barking of walrus can be heard for miles. When the Innuit hunter hears it, he may hitch six or eight dogs to his sledge

Copyright 1908 by Frank Wilbert Stokes.

ESKIMO ENCAMPMENT IN LATE AUTUMN.

The north panel of the East Wall.

WALRUS HUNTING IN THE LIGHT OF THE AURORA BOREALIS

The central panel of the East Wall.

and travel toward the sound, often with only the light of the moon or of the stars to show him the way. When within a thousand yards to the windward of the animals, he tethers his dogs to the ice, and if they are unaccustomed to hunting and will not remain noiseless, he may turn the sledge upside down, to check any attempt on their part to run away.

Armed with a stout harpoon and plenty of walrus-hide line, the Innuit crawls over the ice toward the animals. He conceals himself behind ice blocks or hummocks until the distance between him and the animals is short, then suddenly leaps to his feet, singles out a big bull (as in the painting) and strikes — usually with unerring aim. The whole herd, barking furiously, rushes for the sea. The stricken bull dives, and the walrus-hide line pays out rapidly, but not before the Innuit has deftly thrust his lance, which he carries in his free hand, firmly into the ice. With knee and shoulder braced against the shaft of the lance, he obtains sufficient purchase to play the walrus until the big fellow is so weakened by loss of blood that the hunter can leave his lance to cut two holes in the ice close to the spot where he is standing. Now, whenever the line is slack, he hauls in a few fathoms, and running the noose a couple of times down through one hole and across through the other, obtains a more reliable hold. With the lance now free, he stands over the breathing hole, striking the walrus each time that it rises. When it is finally despatched, he cuts off piece after piece of the meat and seeks his sledge and dogs to carry the spoil home.

Walrus are huge ungainly creatures, weighing upwards of three thousand pounds, but to the nimble Innuit hunter there is usually no difficulty in getting out of harm's way on the ice after he has struck the blow. If, however, the iron point slips, or the ice gives way, or if, as the coils of the line are running out, the hunter's legs become entangled, he is quickly dragged down beneath the water to speedy death.

The Third or Southern Panel. Peterawik in Moonlight.

The third panel represents a winter scene at Peterawik on the shore of Smith Sound. In the foreground at the extreme left is a hunter with sledge and dogs, bringing a load of walrus meat. His snow igloo is at the right, where his wife, carrying a child in her hood, and accompanied by an Eskimo woman, is waiting to welcome him. The sea-ice of Smith Sound stretches far to the horizon at the north; the head-line of Cape Alexander is visible in the distance. The rocks at the right are characteristic of the west coast of Greenland at this latitude, 76° N.

In the spring before the ice breaks up, the Innuit congregate at Peterawik for walrus hunting. They build their snow igloos on the ice foot, that portion of the sea-ice bordering the land. Here they remain

hunting, frolicking and feasting in their joyous fashion, until the sun's warmth has broken up the ice. Then they travel southward, still over the ice, some to the settlements of Inglefield Gulf and others even as far as Cape York.

The West Wall.

The First or Northern Panel — Reindeer Hunting in Summer.

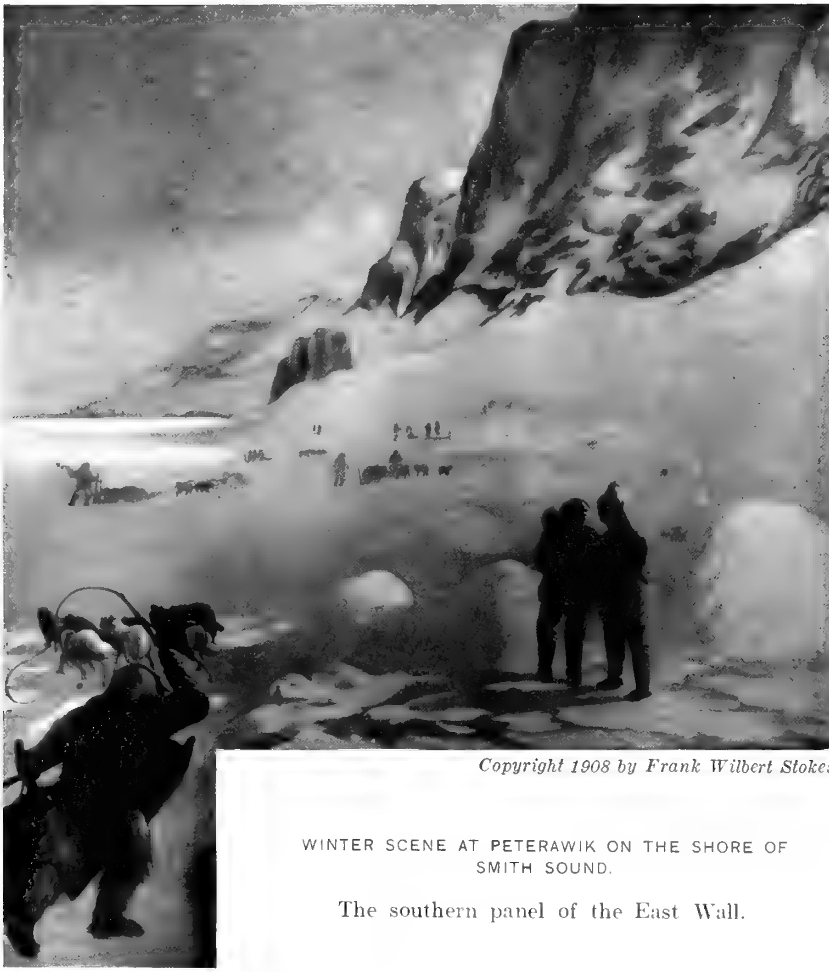
The paintings on the west wall represent Eskimo life during the long Arctic day.

In the middle foreground of the northern panel a hunter, crouching at the top of a rocky prominence, is in the act of drawing his bow of bone and sinew upon a white reindeer,[1] which has espied too late something to excite its curiosity. In the middle distance at the extreme right, is the continuation of the large iceberg of the central panel of the north wall. Icebergs in the Arctic regions are frequently from 150 to 300 feet in height, measure five to seven times this distance below the surface of the sea, and sometimes have a length of three miles. Beyond the iceberg in the distance is a glacier flowing down from the great ice "Sahara" in the interior of Greenland, while to the left is a dark rocky portion of the submerged land.

In the immediate foreground are purple flowers (*Epilobium latifolium*) which nestle in pockets in the rocks. The middle foreground is covered by stunted grass and mosses, especially by reindeer moss on which the deer are feeding. Many flowers bloom in Greenland and other polar lands during the short summer, notably members of the mustard family, and of the pink, rose, saxifrage and grass families. There is one species of sedge known; willows and birches are found, although growing only two to three inches in height; while daisies, buttercups, yellow poppies, harebells, dandelions, gentians and primroses cover the ground in many places.

Another source of bright color in these northern latitudes lies in two species of algæ, one red and the other green. They are microscopic plants that grow on the ice or snow, but they may occur in such profusion as to impart their color to the ground. It is the presence of these algæ

[1] A white caribou (*Rangifer pearyi* Allen) discovered by Peary in 1902 in Ellesmere Land near Lake Hazen, latitude 82° N.



Copyright 1908 by Frank Wilbert Stokes.

WINTER SCENE AT PETERAWIK ON THE SHORE OF SMITH SOUND.

The southern panel of the East Wall.

that explains the famous "crimson glacier" or "crimson snow" near Cape York.

As to edible plants, there are a few even in this extreme northern region. A blueberry which grows partly concealed under the moss can be secured during the greater part of the year, and is eaten with relish by the Innuit. There are several plants of which the roots, leaves, buds and even flowers are eaten. A plant resembling celery (*Archangelica officinalis*) is a favorite article of food. Iceland moss is also eaten. The chief sources of vegetable food, however, are marine. A

Copyright 1908 by Frank Wilbert Stokes.

REINDEER HUNTING IN SUMMER

The northern panel of the West Wall.

ESKIMO IN SEALSKIN CANOE HARPOONING A NARWHAL

The central panel of the West Wall.

seaweed used commonly for food is *Alaria pylaii*, closely allied to "bladderlocks," of Scotland, and in flavor somewhat like asparagus.

The Central Panel — Narwhal Hunting in Summer.

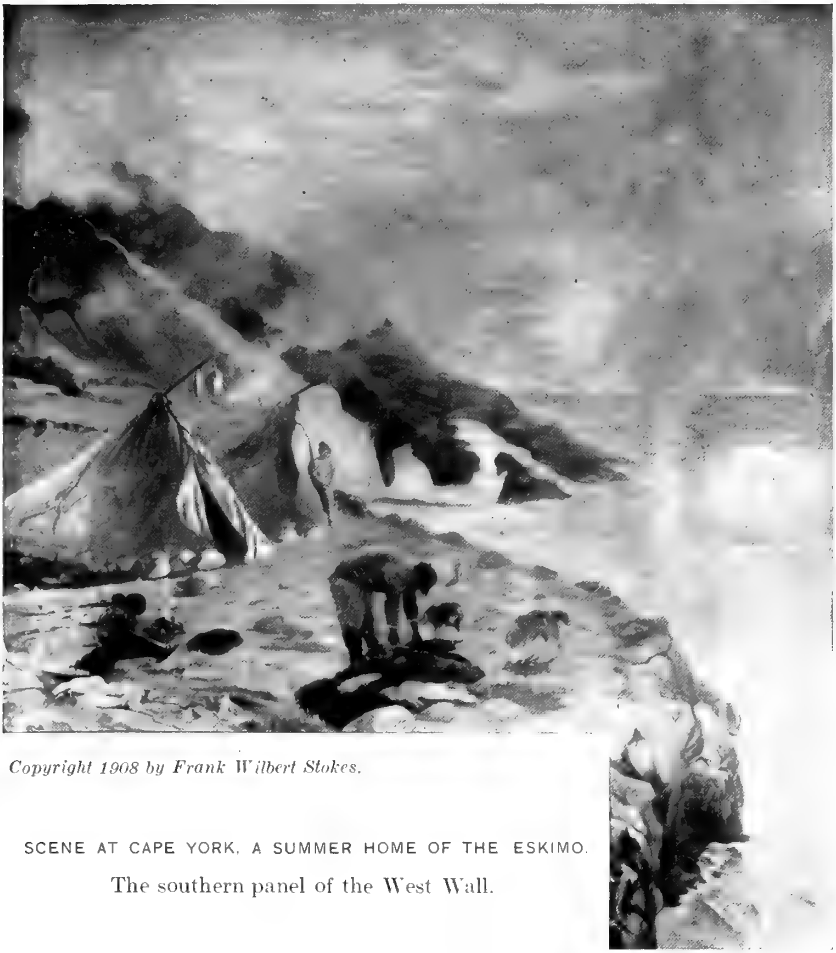
The dramatic center of this panel is an Innuit in his kayak or sealskin canoe in the act of harpooning a narwhal, which is visible beneath the

surface of the water at the left of the boat. To the right in the middle distance are fulmar gulls. In the distance is the great ice river, the Verhoeff glacier.

The narwhal is an animal about which little is definitely known. Some, notably Peary, think that it is the fabled unicorn of the ancients. It occasionally has both a long and a short horn, one of which it may lose, however. The narwhal is blue-black along the back and spotted with dark along the sides, the color fading into ivory white underneath. The thin skin covers a very deep layer of fat or blubber, considered a delicacy by the Innuit. This blubber is eaten raw, as in fact is most of the food in the Arctics, and of course without pepper or salt, neither of which is known to the Eskimo.

In narwhal hunting, the Innuit approaches the animal from the rear and one side, decreasing the distance noiselessly until he is within striking distance. A companion always accompanies the hunter, so that, in the event of his being struck by the narwhal, and his boat overturned, there may be some rescue at hand. The harpoons used in narwhal hunting formerly had heads made of flakes from the iron meteorites near Cape York, but since the first quarter of the nineteenth century the Eskimo have obtained their metal from traders and from whaling and other ships. The harpoon head is joined to a piece of walrus or narwhal ivory, which fits loosely on to the ivory end of the shaft. To the center of this harpoon head, is fastened a line of walrus hide kept in place by the hand that holds the harpoon. The line itself is coiled on the fore part of the kayak, so that it will unwind rapidly and without becoming tangled. Attached to the other end of this line and placed in the after part of the kayak are two objects, a sealskin bag and a drag resembling a box lid. When the animal dives and flees vainly from the pain of the harpoon point imbedded in its flesh, the drag tires it out, and the skin bag, floating on the surface of the water, marks its position and keeps it from sinking. The hunter, who adroitly gets out of the way of the infuriated animal, can thus trace its course and finally tow it home.

The Verhoeff glacier represented in the painting is one of two glaciers at the head of Robertson Bay, on the northern shore of Inglefield Gulf, West Greenland. It was here that Verhoeff, the meteorologist of one of the Peary Expeditions, while trying to cross the glacier alone, lost his life in September of 1892. The sea wall of the glacier is from 150 to



Copyright 1908 by Frank Wilbert Stokes.

SCENE AT CAPE YORK, A SUMMER HOME OF THE ESKIMO.

The southern panel of the West Wall.

200 feet high, but the ice shelves out beneath the water, where the buoyancy of the sea breaks off parts which float away as icebergs. This birth of icebergs at the water's edge of a glacier often causes waves thirty or forty feet in height, miles in extent, and attended by volleys of thunderous reports that are terrifying in the ears of the Eskimo. Each of these glaciers is an arm of the inland ice cap of Greenland, a mighty sheet submerging mountains and valleys to a depth of 5,000 feet or more.

The Third or Southern Panel — Cape York, a Summer Home of the Innuit.

The scene depicted is at Cape York, a summer home of the Innuit, at the head of Melville Bay. Here the Innuit, or Arctic Highlander, as he was misnamed by Sir James Ross, is first met by those visiting the Arctics. The painting gives a view of Cape York looking toward the north.

In the foreground is the camp, where an Innuit leans over a harp-seal which he has killed and is about to cut up, while his dogs are watching for some stray pieces of meat. This man is clothed in bear-skin trousers and a hooded jacket made of about seventy auk skins, the feathers being turned next to the body. He is wearing boots of seal-skin.

To the left in the camp is a girl of about seven years, painted from a sketch made by the artist in 1894. She is clothed in small trousers of fox skin and an upper hooded garment, also of fox skin, and wears boots of sealskin, reaching to the thighs. She is attending a fire of moss and blubber, over which blood soup is being prepared, while guarding from the dogs a piece of meat on the ground at her right. Behind the girl are two sealskin tents (tupekhs) from one of which a young woman is emerging.

Beyond the tents are mountains towering 1500 to 3000 feet above the camp. The summits of these mountains are frequently obscured by dense fogs, from which come continually the wild cries of innumerable multitudes of kittiwake gulls and little auks.

In this bay, but some miles to the eastward, the three meteorites now on exhibition in the foyer of this museum remained for ages. It was Peary who wrested them from their ancient abode and brought them to New York in 1895. From these meteorites, in olden times, the Innuit flaked off pieces for use in knives, harpoons and arrow heads, to aid in the struggle for food and life.

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. October, 1903. *Price,* 10 *cents.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRDS' NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted,* February, 1905. *Price,* 10 *cents.*

No. 15.— PRIMITIVE ART. July, 1904. *Price,* 15 *cents.*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price,* 15 *cents.*

(*Reprinted from The American Museum Journal.*)

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1905. *Price,* 15 *cents.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D MATTHEW, Ph. D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Price,* 15 *cents.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price,* 15 *cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Price,* 10 *cents.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price,* 15 *cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Price,* 10 *cents.*

(*Published as a separate series.*)

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price,* 10 *cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Price,* 15 *cents.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price,* 10 *cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Price, 15 cents.*

No. 28.— THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price.* 15 *cents.*

No. 29.— THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909 *Price,* 10 *cents.*

No. 30.—THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO. November, 1909. *Price,* 5 *cents.*

The American Museum Journal

Edmund Otis Hover, *Editor.*
Mary Cynthia Dickerson, *Associate Editor.*
Frank M. Chapman, Louis P. Gratacap, William K. Gregory, *Advisory Board.*

The Journal is sent free to all Members of the Museum.

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY.

For Sale at the Museum.

(Issued as supplements to The American Museum Journal.)

No. 1.— THE BIRD ROCK GROUP. By F. M. Chapman, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price, 10 cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. Smith, Assistant Curator of Archæology. December, 1901. *Price, 10 cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. Matthew, Ph. D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By Louis P. Gratacap, A. M., Curator of Mineralogy. February, 1902. *Revised edition,* May, 1904. *Price, 10 cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. Allen, Ph. D. Curator of Mammalogy and Ornithology. March, 1902 *Revised edition,* February, 1904. *Price, 10 cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By George H. Pepper, Assistant in Anthropology. April, 1902. *Second edition,* May, 1909. *Price, 10 cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By William Beutenmüller, Curator of Entomology. May, 1902. *Price, 15 cents.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By George H. Sherwood, A. M., Assistant Curator. November, 1902. *Price, 10 cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. Matthew, Ph. D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition,* May, 1905. *Price, 10 cents.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By William Beutenmüller, Curator of Entomology. February, 1903. *Price, 10 cents.*

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. Mead, Assistant in Archæology. July, 1903. *Price, 10 cents.*

(Continued on page 3 of cover.)

AMERICAN MUSEUM OF NATURAL HISTORY

A BRIEF HISTORY OF ANTARCTIC EXPLORATION

GUIDE LEAFLET No. 31

MARCH, 1910

AMERICAN MUSEUM OF NATURAL HISTORY

Seventy-seventh Street and Central Park West, New York City

The American Museum of Natural History was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are as follows:

Annual Members	$10	Fellows	$500
Sustaining Members (Annual)	25	Patrons	1,000
Life Members	100	Benefactors (Gift or bequest)	50,000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year.

JEAN CHARCOT

French Antarctic Expedition, 1908-1910

Pourquoi Pas

During his second expedition Dr. Charcot passed south of the Palmer Archipelago, discovered Adelaide Island and sighted points on the Antarctic Continent named Loubet, Fallieres and Charcot Lands, perhaps continuations of Graham Land. He sailed westward along the ice-front to long. 128° 20' W.

The party conducted scientific studies of a varied nature. Two antarctic flowering plants were found in bloom on the southeastern extremity of Adelaide Island. Meteorologic and oceanographic observations were made at various places. The work of the *Francaise* was amplified and extended in every direction. On February 11, 1910, the expedition reached Punta Arenas.

ROALD AMUNDSEN

Norwegian South Polar Expedition, 1910-1911

Fram

Captain Amundsen left Norway on August 9, 1910, on Nansen's well-known ship the *Fram*, with provisions for two years and ninety-seven dogs. The ship arrived at the Bay of Whales, Ross Barrier, on January 14, 1911.

Winter quarters were constructed on the barrier two nautical miles from the ice-margin and called "Framheim."

From February 10 to April 11, 75,000 pounds of provisions were distributed at three depots, lat. 80°, 81° and 82° S. The sun disappeared on April 21 and returned on August 24. On October 20 the weather was favorable and a start was made for the South Pole along the 164th meridian of west longitude. Ross Barrier proved to be comparatively smooth to lat. 86° S. and long. 163° W. At this point an east-northeastern range meets the mountains of South Victoria Land. The main depot was established at the foot of the mountains on Ross Barrier, lat. 85° S., long. 165° W. The course of the party from the low Ross Barrier to the high Haakon VII. Plateau, 10,000 feet above the sea, was over the long, crevassed Devil's Glacier.

On December 6, the party reached the maximum height of the plateau, 10,750 feet. The surface remained level to lat. 88° 25', where it began to slope down to the polar area. On December 11, the party arrived at lat. 89°, a region where perfectly fine weather

existed and the ice was covered with 6 feet of snow. On December 14, reckonings were taken which indicated that the pole was five miles to the south. It was on December 16, 1911, that the party arrived at the South Pole. A small tent was pitched, the Norwegian flag and the *Fram* pennant hoisted, and the spot christened "Polheim." A letter addressed to H. M. King Haakon VII. was left in the tent, which Captain Scott found a month later and started on its long homeward journey. The distance of 750 nautical miles from "Polheim" back to "Framheim" was covered without mishap in 39 days.

During the 99 days that the polar party was absent, Lieutenant Prestrud and two companions explored the surroundings of "Framheim" and succeeded in reaching King Edward's Land, discovered by Scott on a previous expedition.

Captain Nilsen with his companions on the *Fram* succeeded in making an 8,000 nautical mile cruise from Buenos Aires to Africa and back. They made 60 oceanographic observations, and on February 15, 1911, carried the Norwegian flag farther south than a ship had ever floated before.

WILLIAM FILCHNER

German Antarctic Expedition, 1911-1912

Deutschland

On December 11, 1911, the *Deutschland* left South Georgia and sailed southward. On December 17, heavy pack-ice was encountered. On December 18, lat. 76° 48' S., long. 30° 25' W., a gently rising inland ice-cap was sighted, reaching a height of 200-300 meters and ending seawards in a perpendicular wall 20-30 meters high. The ship, following the ice-edge, reached Vahsel Bay a little north of lat. 78° S. This bay was bounded on the west by a low barrier resembling that of the Ross Sea. At a higher elevation to the south, nunataks appeared through the ice cover. As no landing could be effected on the main ice sheet the party returned to South Georgia in March, 1912, and disbanded December 19, 1912.

R. F. SCOTT

British Antarctic Expedition, 1910-1913

Terra Nova

On June 1, 1910, the *Terra Nova* left London. On November 29, when the expedition left New Zealand, Captain Scott had with him fifty-ninè officers, scientists and seamen, and a full equipment for

polar work. The nineteen Siberian sledge ponies on board were the first to be used in antarctic exploration.

While passing through the pack-ice, magnetic observations, deep-sea soundings, serial sea temperatures and marine specimens were obtained.

On January 4, 1911, a landing was made at Cape Evans and a base established. Depots of food were established before the antarctic winter set in.

On October 24, the South Pole Party, with four supporting parties, left the winter camp. On January 4, at lat. 87° 34', the last supporting party turned back.

The Polar Party covered the remaining 145 geographical miles in a fortnight. After passing lat. 88°, Captain Scott came across Amundsen's dog tracks and followed them to the polar area. Scott, Wilson, Oates, Bowers and Seaman Evans reached the South Pole on January 17, 1912, 32 days after Amundsen. All members of Captain Scott's Polar Party perished on the return journey. The records together with the famous death message of Captain Scott were recovered eleven miles from One Ton Camp by the search party.

The short expedition led by Taylor and Wilson to various points in the vicinity of MacMurdo Sound were successful, while the epedition to King Edward VII. Land was a failure.

Many scientific data were collected by the various parties of this expedition.

DOUGLAS MAWSON

Australasian Antarctic Expedition, 1911-1914

Aurora

Dr. Douglas Mawson of the University of Adelaide, Australia, left Hobart, Tasmania, in December, 1911, on board the *Aurora* to explore the long stretch of coast known as Wilkes Land, lying between Cape Adare and Kaiser Wilhelm II. Land, His ship was well equipped for oceanographic and magnetic work. A number of Greenland dogs and Norwegian-built sledges were taken. Dr. Mawson and the main party were landed in Commonwealth Bay, Wilkes Land, on January 19, 1912.

On February 20, Mr. Frank Wild and seven companions, constituting a second party, were landed by Captain Davis of the *Aurora*, 1,000 miles east of the main party. They discovered a tract of land

having about 350 miles of coast, which they named Queen Mary's Land.

On a sledging journey across King George V. Land, Captain Ninnis was lost in a crevasse and Dr. Bruce died of exposure. Dr. Mawson barely escaped. He and five companions were obliged to remain in the winter camp in Commonwealth Bay through 1913. The *Aurora* returned for them the following spring and Dr. Mawson reached Port Adelaide, South Australia, late in February, 1914.

From a scientific standpoint his expedition was very successful.

A Brief History of Antarctic Exploration

A Guide Leaflet explanatory of the

Spherical Chart of the Antarctic Regions

exhibited in the

American Museum of Natural History

No. 31

of the

Guide Leaflet Series

of the

American Museum of Natural History

Edmund Otis Hovey, *Editor*

New York. Published by the Museum. March, 1910

A BRIEF HISTORY OF ANTARCTIC EXPLORATION

INTRODUCTION

The chart (which is a section of the Globe) is designed to illustrate our present knowledge of the geography of the Antarctic regions, and to indicate the courses taken by the principal Antarctic explorers.

The visitor is supposed to be looking down upon the South Pole, and therefore the area of his horizon extends in all directions toward the north, reaching beyond the Antarctic Circle [66° 30′ south, drawn in red] to the parallel of 60° south. It is a relatively small portion of the earth's surface, as will be seen by examining the small globe.

Since a degree of latitude measures about 70 miles,[1] the concentric circles representing parallels (which are 5° apart) are about 350 miles from one to another.

It is about 2,100 miles from the margin of the chart to the center, or from the parallel of 60° to the South Pole.

Meridians, drawn every 10° apart, intersect at the Pole. The meridian of Greenwich, indicated by three parallel lines, lies vertically.

The degrees of longitude are indicated along the margin, and the degrees of latitude are indicated by numerals placed on the respective parallels.

More readily to understand the historical description, it will be worth while for the visitor to remember

[1] Throughout this Leaflet distances are expressed in "statute" miles, a statute mile being about six-sevenths as long as a geographical or nautical mile.

That were the "meridian of Greenwich" continued northward, it would finally pass through Greenwich, England;

That all points lying to the right of this line are in east longitude;

That those lying to the left are in west longitude;

That were the meridian of 74° west (on the left, represented in red) extended to the north, it would pass through New York;

That the southerly projection of South America lies on the meridian of 70° west, to the left of the chart, about 600 miles from the South Shetlands;

That the southern projection of Africa lies on the meridian of 20° east, above the chart, more than 2,000 miles from the Antarctic ice.

That New Zealand lies on the meridian of 170° east, below the region included in the chart, about 1,700 miles from Victoria Land;

That between these points lie the vast expanses of the South Atlantic, South Indian and South Pacific Oceans, respectively.

The visitor, then, having established his "points of compass," may now with greater profit consult the historical labels which are attached to the rail, in the order of the dates of discovery.

ANTARCTIC EXPLORERS AND THEIR DEEDS

JAMES COOK, 1772-75

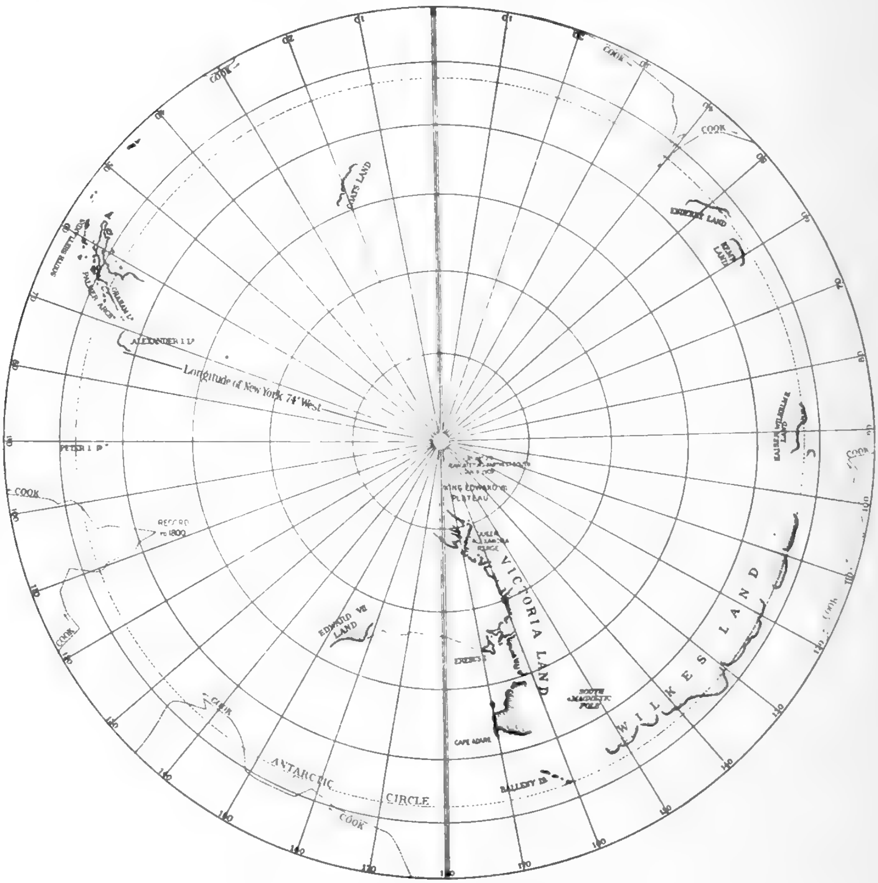
Resolution and *Adventure*

[**The course is indicated on the chart by a white line.**]

There was little definite knowledge of lands lying in the far south until Captain Cook, a young man of the British Navy (who, by the way, had gained distinction in North America at the siege of Quebec), sailed to the South Pacific (1768–1771) to observe the transit of Venus, and in doing so passed south of New Zealand and thus corrected the belief that this island was a part of an extensive Antarctic continent.

Later, in 1772, Cook was commissioned by the British Admiralty to command two vessels and to examine into the question of the existence of a great southern continent. He sailed from Plymouth in July, reached Cape Town in October, and entered the area of this chart near the 20th meridian of east longitude. He took an easterly course, then one abruptly south, and, on January 17, 1773, was the first person to cross the Antarctic Circle. Further progress being blocked by the ice, Cook took a northerly course. He missed the Crozet and Kerguelen islands (which lie without the area of the present map, but may be noted on the small globe). He then turned to the south, and crossed the 60th parallel near the 90th meridian, the ice

preventing him from seeing the land, which has lately been discovered and named in honor of the German Emperor, Kaiser Wilhelm II. He then continued, sometimes north and sometimes south of the 60th parallel, to about 150° E., when cold weather drove him north, where he wintered.



ANTARCTIC REGIONS

ROUTE FOLLOWED BY JAMES COOK, 1772–1775

He then returned, crossed the 60th parallel near 180° and entered the area of the chart, crossed the Antarctic Circle a second time near 150° W., turned and made a wide detour to the north, and proved that there could be no

considerable land between New Zealand and Cape Horn. He again entered the area here represented at about 120° W., crossed the Antarctic Circle for the third time, in January, 1774, near 110° W., and made his farthest south (71° 10′), a record that was not broken for half a century. It was here that he saw the solid ice like a ridge of mountains. Cook then sailed north in search of alleged land (Juan Fernandez), which he proved not to exist, and the tired party then spent the winter in the South Pacific.

On the return of the Antarctic spring, November, 1774, Cook left New Zealand and renewed his efforts. He took an easterly course near the 55th parallel until he reached the islands of Tierra del Fuego. He then rounded Cape Horn and, having proved the non-existence of a continent in the South Pacific, began his search for the "Continent of the South Atlantic"—if such should exist. He discovered South Georgia, near the 40th meridian of west longitude, but not sufficiently south to be shown on this chart. This was the first typical Antarctic land that he had found. He then barely crossed the 60th parallel, discovered the Sandwich group (examine smaller globe), which, surrounded by fields of ice, he felt might be a part of the "Southern Land." Cook then left the area of this map, sailed north-easterly, shaping his course for Cape Town, and thence to England, where he ended his extraordinary voyage. It is noteworthy that Cook, the first successful Antarctic explorer, not only circumnavigated the Antarctic regions, but proved the non-existence of any extensive Antarctic land mass extending north of the Antarctic Circle.

1775-1819

From the time of Cook's voyage, 1775, this region remained unexplored and practically unvisited for a period of more than forty years, although it is true that at the

beginning of the nineteenth century several American vessels regularly visited the shores of South Georgia and the neighboring islands off the coast of South America for seals. The more enterprising of these doubtless discovered many Antarctic islands that they never took the pains to chart or even to report upon.

WILLIAM SMITH, 1819

Williams

[The course is not indicated.]

In 1819, Captain William Smith, while sailing a British merchantman, reported the discovery of the South Shetlands (see meridian 60° W.) and sailed along their coast for a distance of 250 miles.

N. B. PALMER, 1821

Hero

[The course is not indicated.]

In 1821, an American sealer, Captain Palmer, sailed south from the Shetlands, discovering volcanic islands which have been named the Palmer Archipelago.

Captain George Powell, a British sealer, accompanied Palmer, and discovered and charted, in 1821 and 1822, the South Orkney Islands (40°–50° W.).

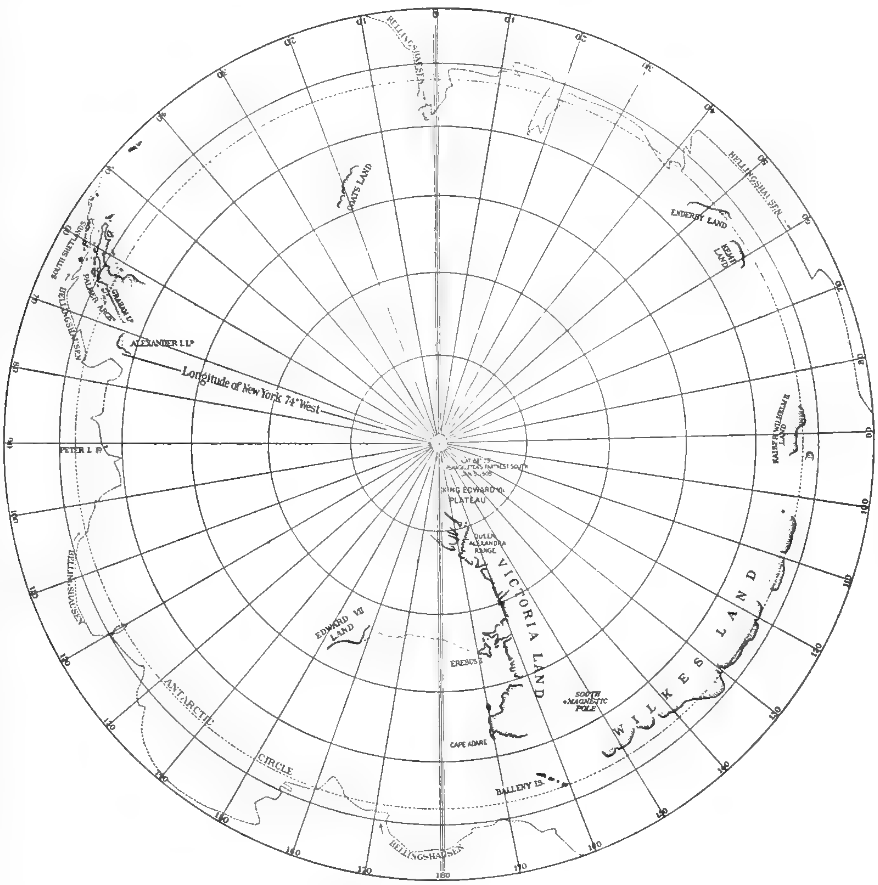
F. G. BELLINGSHAUSEN, 1820-1821

Vostok and *Mirny*

[The course is indicated by an orange line.]

After the British expedition of Captain Cook, the first really important expedition to the South Polar regions was under the patronage of the Russian Emperor, Alexander II,

who appointed Bellingshausen to the command. With two vessels Bellingshausen sailed to the south in January, 1820, near the islands of the Sandwich group (discovered by Captain Cook), then easterly, and entered the area of this chart near the meridian of 10° W.



ANTARCTIC REGIONS

Route followed by F. G. Bellingshausen, 1820–1821

Bellingshausen turned abruptly south, crossed the Antarctic Circle, entered an absolutely unexplored sea, and stopped only when he met the impenetrable ice of the 70th parallel. He then continued toward the east, and, follow-

ing the edge of the ice, crossed the Antarctic Circle a second time, reaching 69° S., near the meridian of 20° E., in February, 1820. He then retreated, proceeded farther eastward, and crossed the Antarctic Circle a third time, near the spot where Cook made his first crossing.

Bellingshausen then proceeded easterly near the 60th parallel, leaving the area of this map, near the meridian of 90° E., and shaped his course for Sydney, Australia.

In November, 1820, Bellingshausen again sailed to the south, crossed the 60th parallel near the 160th meridian, met the pack ice at the 65th parallel, crossed the Antarctic Circle for the fourth time (164° W.), and was obliged then to take a course north of Cook's. He crossed the Circle the fifth time on the 120th meridian west. The ice drove him temporarily to the north, but he returned, and for the sixth time crossed the Circle, at 100° W., and continuing reached his farthest south—69° 52′. Near this point he discovered Peter Island, the most southerly land then known. Still farther to the east, he discovered Alexander Island, when he was again forced by the ice to retreat, and, entering the South Shetland group, met there, February 4, 1821, among others, Captain Palmer, already mentioned. Thus ended one of the most successful and important of Antarctic expeditions.

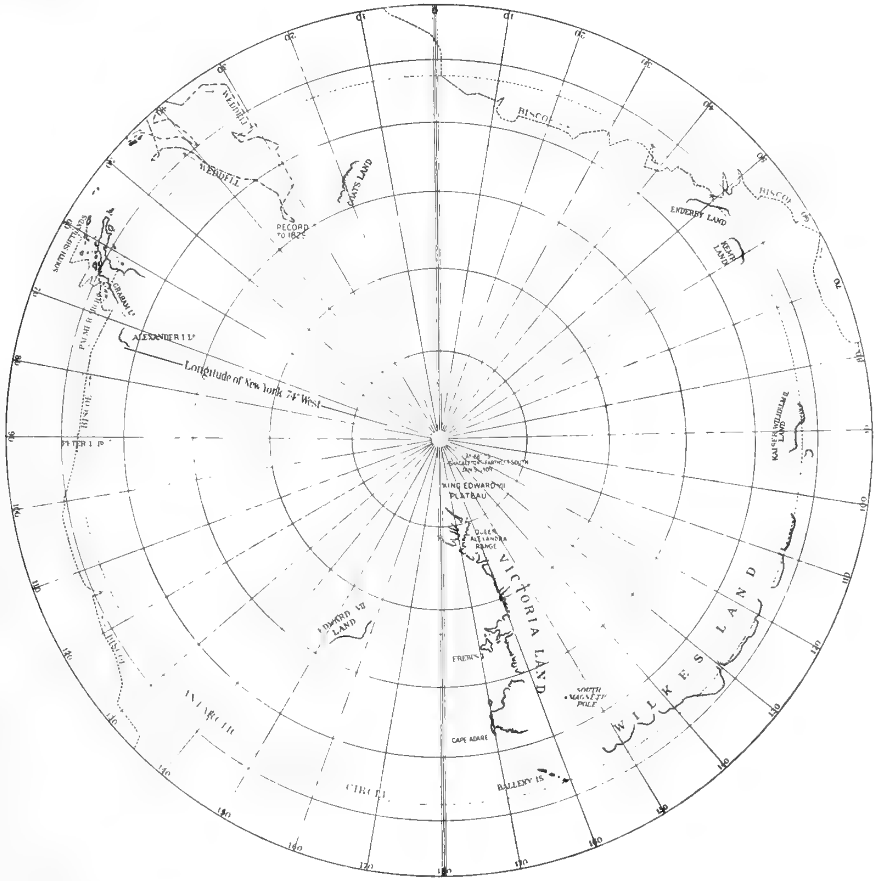
JAMES WEDDELL, 1823

Jane and *Beanjoy*

[The course is indicated by a pink line.]

In 1823, James Weddell, a brave Englishman, after having explored the South Shetlands and worked around the South Orkneys, forced two small sealing vessels southward through the sea which bears his name, to 74° 15′ S., a point 214 nautical miles nearer the pole than had been

reached by Cook, thus breaking a record that had stood nearly fifty years.



ANTARCTIC REGIONS

Routes followed by James Weddell, 1823; John Biscoe, 1830–1832

JOHN BISCOE, 1830-1832

Tula and *Lively*

[The course is indicated by a blue line.]

Enderby Land, lying at the intersection of the meridian of 50° E. and the Antarctic Circle, was discovered in 1831 by Biscoe, a British sealer exploring under a commission

from the merchant firm of Messrs. Enderby, who had entered the South Polar regions by way of the Sandwich group.

The course of Biscoe will be found entering the present map near the meridian of Greenwich; thence passing to the south, across the course taken by Bellingshausen, eleven years earlier, to the point on the 40th meridian east reached by Cook and Bellingshausen, thence along the Antarctic Circle to Enderby Land.

Severe sickness and other trials now compelled Biscoe to turn north, and he left the area of this map near the 80th meridian. He wintered in Tasmania. With the return of warm weather, he sailed from Tasmania east, crossed the 60th parallel near 140° W., followed near the course of Bellingshausen, crossed the Antarctic Circle near the meridian of 80° W. and entered Bellingshausen Sea, where he discovered land, now known as the Biscoe Islands.

Biscoe, unacquainted with the earlier work of the Russians, supposed that he had discovered land lying farther to the south than that found by any other explorer. He landed on the Palmer Archipelago and described new land which, in honor of Lord Graham, he called "Graham Land." He then returned home.

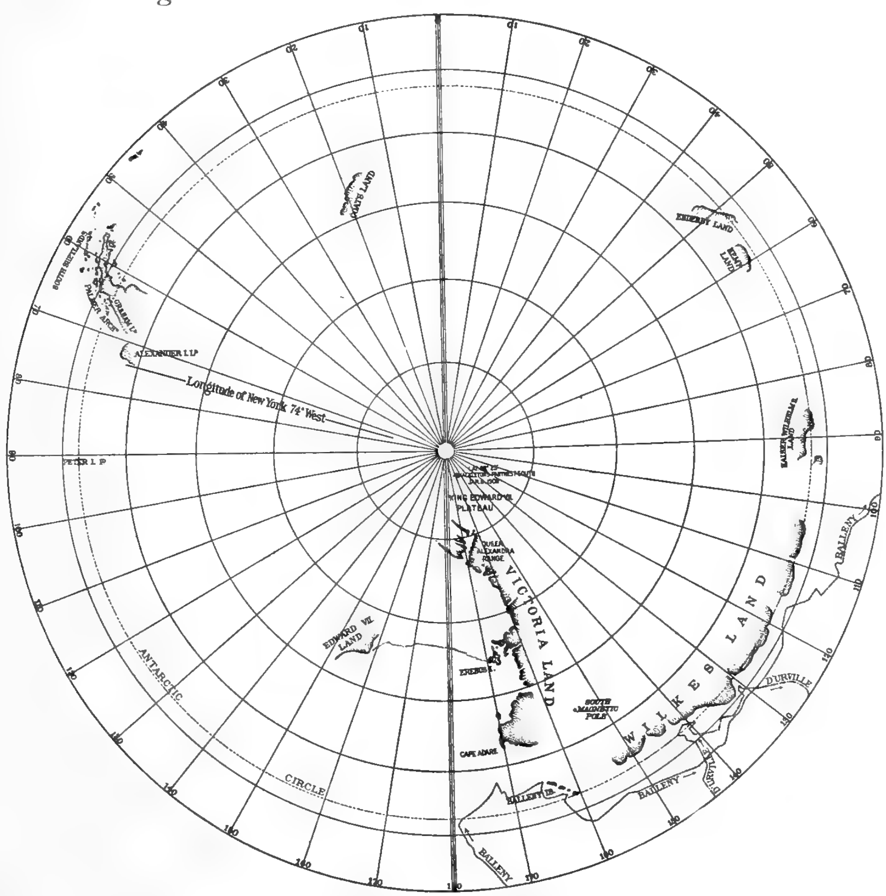
DUMONT D'URVILLE, 1837-1840

Astrolabe and *Zelée*

[The course is indicated by a green line.]

In September, 1837, the French sent Commander d'Urville, in charge of two warships, to explore in the south. He attempted to enter Weddell Sea, but ice prevented. He then sailed to the westward and early in 1838 explored the land to the south of the South Shetlands, dedicating it to his sovereign, Louis Philippe. He then

entered the Pacific, where he remained for two years. Leaving Tasmania and again entering the southern seas, d'Urville found land, stretching indefinitely to the east and west, in the latitude of the Antarctic Circle and near the meridian of 140° E. Landing parties found the rocks to be of granite.



ANTARCTIC REGIONS

ROUTES FOLLOWED BY DUMONT D'URVILLE, 1837–1840; JOHN BALLENY, 1838–1839

While in this neighborhood, d'Urville unexpectedly met an American expedition under Wilkes.

With the return of d'Urville, French activity in the Antarctic was brought to a close, until its recent revival.

JOHN BALLENY, 1838-1839

Eliza Scott and *Sabrina*

[The course is indicated by a brown line.]

In 1838, the Enderbys (who, as before stated, had made it possible for Biscoe to circumnavigate the Antarctic), in conjunction with other London merchants, sent two vessels under John Balleny into the Antarctic, with instructions to push as far to the south as possible. Balleny entered from New Zealand, near the meridian of 180° and crossed Bellingshausen's track. Entering what was later known as Ross Sea, he discovered in 1839 the group of small volcanic islands which bears his name. This was the first land found within the Antarctic Circle south of New Zealand, and its discovery was the first step toward the final discovery of Victoria Land. Balleny left the area of this map at 100° E., failing, however, to discover the land which we now know was just south of his course. Members of this expedition, on returning, reached London in time to meet Ross before the departure of the *Erebus* and *Terror*.

CHARLES WILKES, 1839-1840

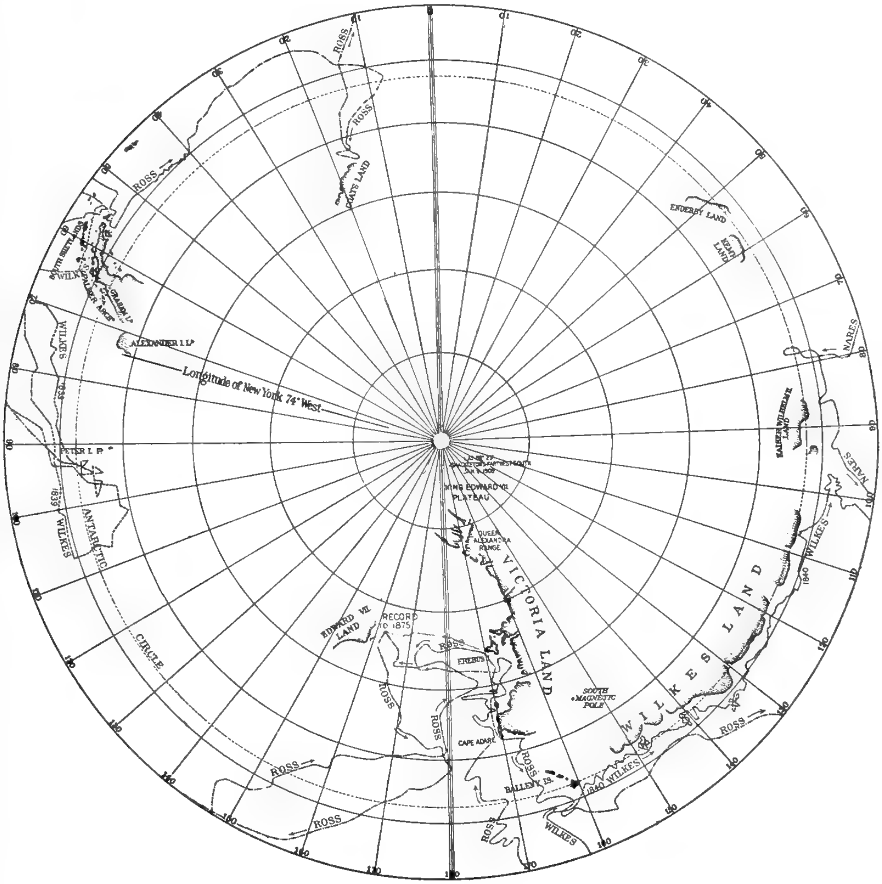
Vincennes, Peacock and *Porpoise*

[The course is indicated by a red line.]

In February, 1839, Lieutenant Charles Wilkes, at the head of the United States Exploring Expedition, with a squadron of six vessels poorly equipped and poorly adapted to polar work, entered the South Polar regions from Tierra del Fuego.

He first made an effort to explore land to the south of the South Shetlands, in the neighborhood of 60° W., and then in the neighborhood of Cook's farthest south, 105° W. These efforts were unsuccessful. Four of the vessels then proceeded to Sydney, Australia, whence two under

Wilkes and two under Ringgold roughly explored the strip of land, or lands, lying near and parallel to the Antarctic Circle, which extends from the Balleny Islands (165° E.) to 95° E., a distance of 1500 miles, a tract now known in



ANTARCTIC REGIONS

Routes followed by Charles Wilkes, 1839–1840; James Clark Ross, 1839–1843; G. S. Nares, 1874

general as Wilkes Land. He thus took a course in this area more southern than that of any previous explorer known to him, although d'Urville, in a quick sail to the south from Tasmania, had discovered Adélie Land on the

140th meridian at about the same time. The American and French expeditions met each other near this point. The course of Wilkes, as he returned from the Antarctic, will be found to cross the 60th parallel near the meridian of 100° E.

JAMES CLARK ROSS, 1839-1843

Erebus and *Terror*

[The course is indicated by a purple line.]

James Clark Ross, a nephew of Sir John Ross, the Arctic explorer, and one who had had several years of Arctic experience (indeed it was he who in 1831 had sledged to the North Magnetic Pole and planted there the British flag), left Tasmania in 1840 in command of the *Erebus* and *Terror*. The primary object of the expedition was to make certain magnetic explorations in the extreme south. In less than five months Ross returned to report the extraordinary results of his expedition.

Fully informed concerning the discoveries of Wilkes, he determined to seek high latitudes to the east of the Balleny Islands, and with little difficulty sailed into a new sea and discovered land extending from Cape Adare to the volcanoes of Erebus and Terror, 77° S.,—a distance north and south of approximately 400 miles. He thus reached a point considerably farther south than that attained by any previous explorer. These discoveries, taken conjointly with those of Wilkes, indicated the probability of the existence of a large polar land mass.

Ross plotted a part of the shore line of that portion of the Antarctic Continent now known as Victoria Land. Returning, he crossed the Antarctic Circle near the meridian of 170° W. His course leaves the area of this map at 140° W., reënters it at 130° W., again passes out to the

north, enters it anew near 50° W., and skirts the ice barrier across the mouth of Weddell Sea to the meridian of 20° W. He finally reached England in September, 1843, having been absent for more than four years.

G. S. NARES, 1874

Challenger

[The course is indicated by transverse red and white bands.]

In 1874, the British steamship *Challenger*, equipped for scientific work and carrying an able scientific staff, entered the Antarctic from Kerguelen Island, crossing the Circle near the 80th meridian east, and then followed the drift ice easterly as far as Wilkes Termination Land. The *Challenger* was the first steam vessel to enter the Antarctic, and the first provided with adequate sounding and dredging apparatus. As a result of the *Challenger's* investigations, the existence of an Antarctic continent was proved and the fact that a wealth of animal life covers the floor of the Antarctic seas was established.

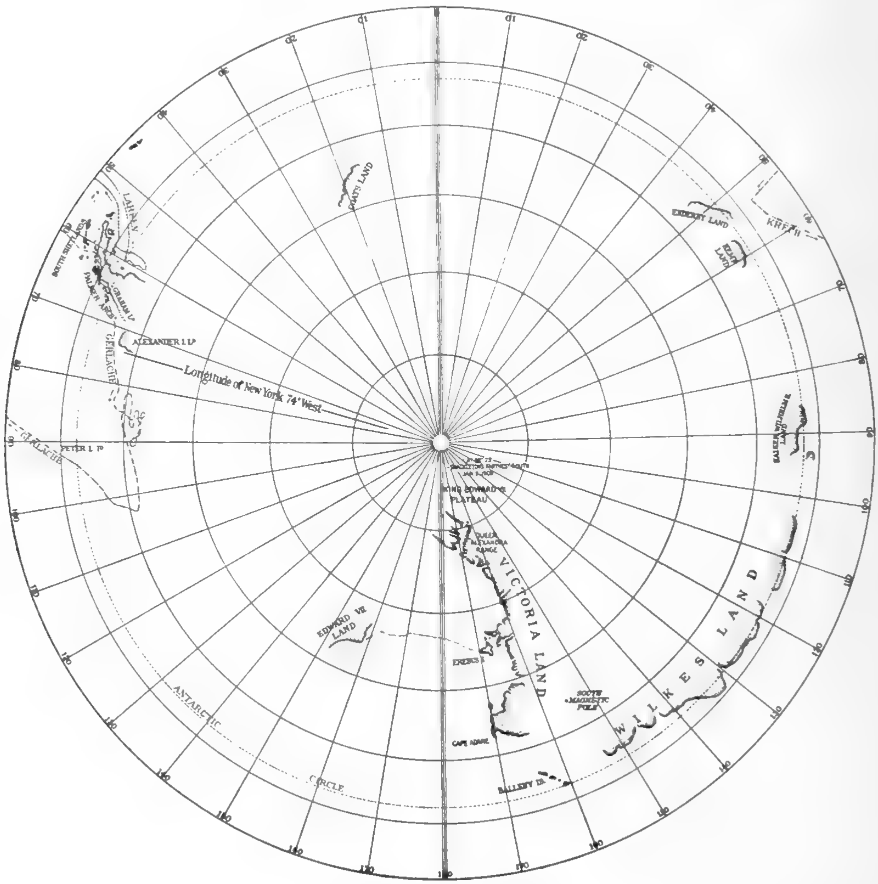
C. A. LARSEN, 1893-1894

Jason

[The course is indicated by red, yellow and blue bands.]

During the last quarter of the nineteenth century, with the waning of the whaling industry in the north and with the report of the existence of large numbers of whales in the south, the small steam whalers of Scotland and Scandinavia made several expeditions into the Antarctic. Among these was the *Jason*, commanded by C. A. Larsen, the same vessel and the same captain that a few years before had left Nansen on the east coast of Greenland. The *Jason* landed south of the South Shetlands and Larsen discovered the

first Antarctic fossils (mollusks and coniferous wood). Previous to this, samples of rock from the Antarctic had been igneous in origin. The fossils proved that at least part of this region was not volcanic.



ANTARCTIC REGIONS

ROUTES FOLLOWED BY C. A. LARSEN, 1893–1894; ADRIEN DE GERLACHE, 1898–1899; ADALBERT KRECH, 1898–1899

The following year Larsen returned to the Antarctic, discovered King Oscar II Land, and forced the *Jason* (the second steamer to cross the Antarctic Circle) to a point 68° 10′ S., roughly exploring the eastern coast of

Graham Land. He discovered two active volcanoes near 65° S.

The *Jason* subsequently was renamed the *Stella Polare* and carried the Duke of the Abruzzi's Arctic expedition to Franz Josef Land, whence Captain Cagni, in 1900, made the nearest approach to the North Pole that had been accomplished up to that time.

LEONARD KRISTENSEN, 1894-1895

Antarctic

[The course is not indicated.]

In November, 1894, the steam sealer and whaler *Antarctic*, under Leonard Kristensen, sailed south from New Zealand with C. E. Borchgrevink, who took passage as a common sailor, and entered Ross Sea. The *Antarctic* followed, in part, the course taken fifty-five years before by Ross. The party landed on Possession Island and discovered a lichen—the first evidence of terrestrial plant life obtained within the Antarctic Circle. A few days later the first landing on the Antarctic Continent was made at Cape Adare. As whales of commercial value were not found, the *Antarctic* returned.

ADRIEN de GERLACHE, 1898-1899

Belgica

[The course is indicated by red, yellow and black bands.]

Belgium now entered the field of Antarctic work. Adrien de Gerlache, a lieutenant in the Belgian navy, left Tierra del Fuego on the *Belgica* in January, 1898, with several scientists and with Dr. F. A. Cook of Brooklyn as ship's surgeon. The Belgians ran the first line of soundings from Cape Horn to the South Shetlands. The naturalists made

many landings, taking photographs and collecting natural history specimens from the shores of Palmer and Graham Lands. In their zeal to explore still farther south, they were caught in the ice at 71° 30′ S., and were the first explorers to pass the winter within the Antarctic Circle.

ADALBERT KRECH, 1898-1899

Valdivia

[The course is indicated by diagonal red, white and black bands.]

The *Valdivia*, of the Hamburg-American Line, commanded by Adalbert Krech, was carefully fitted out for scientific work by Professor Chun of Leipzig. Her first important problem was to determine the existence or non-existence of Bouvet Island, which had been sought in vain by Cook, Ross and Moore, and had not been seen for seventy-five years. It was found 54° 26′ S., 3° 24′ E. The *Valdivia* then proceeded towards Enderby Land, and thence to Kerguelen Island, making important soundings and dredgings.

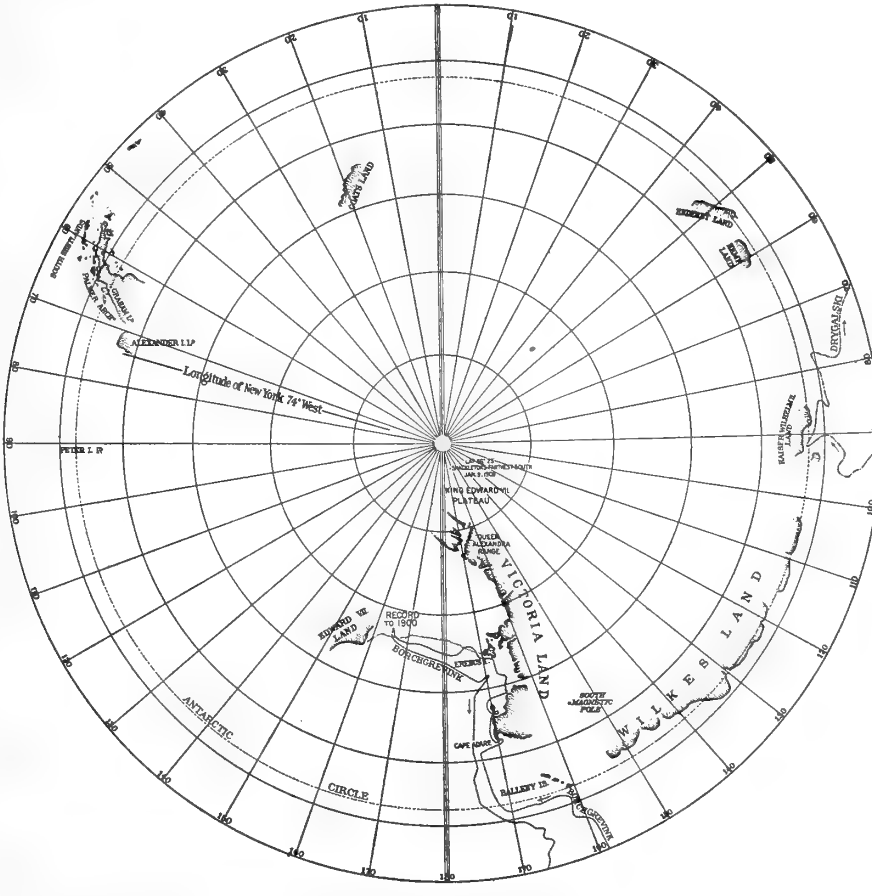
C. E. BORCHGREVINK, 1899-1900

Southern Cross

[The course is indicated by red, alternately narrow and broad, and white bands.]

In February, 1899, C. E. Borchgrevink, a member of Kristensen's expedition of 1894, determined to spend the winter in the Antarctic and again crossed the Circle—this time not as a sailor, but in command of an English expedition. He landed with his party of ten on Victoria Land, near Cape Adare, and bade adieu to his vessel, the *Southern Cross*, which sailed for warmer latitudes, to return at the close of the Antarctic winter. The unhappy members of the

Belgian expedition on the opposite side of the Pole were endeavoring to extricate themselves at the very time Borchgrevink and his companions entered winter quarters. The season was severe and the *Southern Cross* was most welcome on her return, January 28, 1900. A course was then



ANTARCTIC REGIONS

ROUTES FOLLOWED BY C. E. BORCHGREVINK, 1899–1900; ERICH VON DRYGALSKI, 1902–1903

taken still farther to the south along the coast of Victoria Land. Landings were made and the shore of Ross Sea (78° 21′ S.) was reached. A brief sledge trip reached 78° 50′ S. The party then sailed north for Auckland.

ERICH von DRYGALSKI, 1902-1903

Gauss

[The course is indicated by transverse red, white and black bands.]

Professor Drygalski's expedition was made in the German barkentine, *Gauss*, which was designed for strictly scientific work. She was modeled on the lines of the *Fram* and manned by men who had had polar experience. The *Gauss* sailed from Kerguelen Island and in February, 1902, entered the pack near Wilkes Termination Land. Land was soon sighted, but the vessel was caught in the ice and Drygalski was compelled to enter winter quarters. Sledge parties and views from a balloon located Kaiser Wilhelm II Land. The party was liberated the following February and returned to Germany. The collections of the *Gauss* are now being worked up.

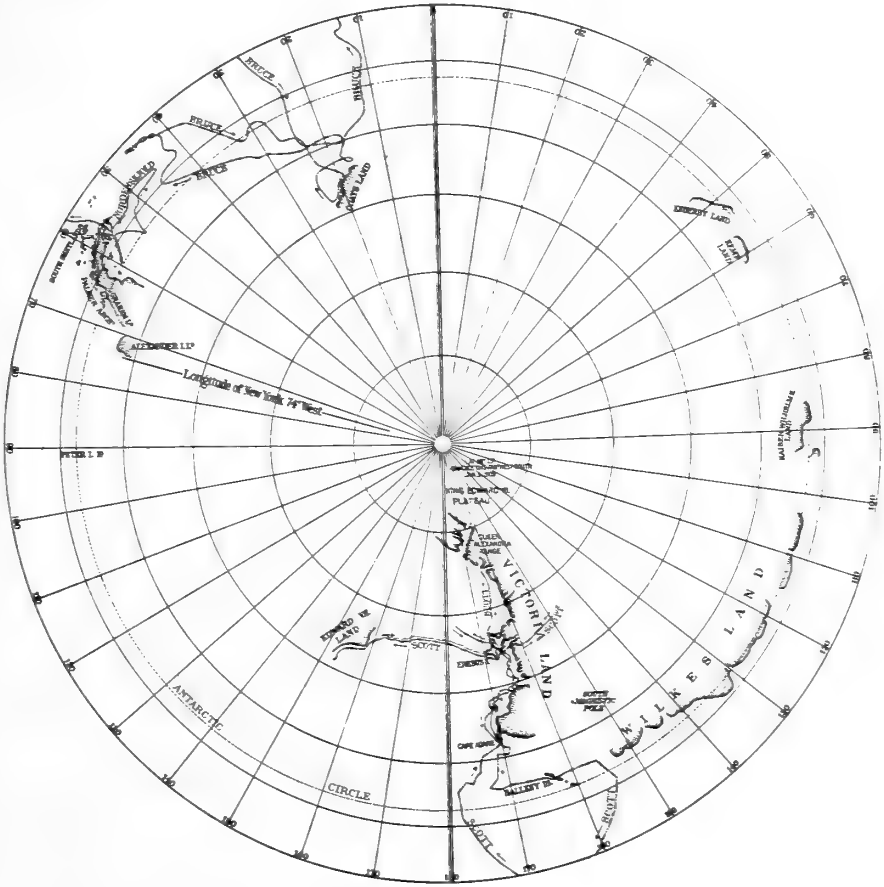
OTTO NORDENSKJÖLD, 1902-1903

Antarctic

[The course is indicated by red and blue bands with yellow dots.]

The geologist, Otto Nordenskjöld, nephew of the Swedish Arctic explorer, Baron A. E. von Nordenskjöld, obtaining funds from his countrymen, secured Kristensen's vessel, the *Antarctic*, engaged C. A. Larsen (earlier attached to the *Jason*), and leaving the South Shetlands in January, 1902, explored in the neighborhood of King Oscar II Land. Landing with three companions to spend the winter on Snow Hill Island, he directed the *Antarctic* to explore in lower latitudes and to return the following spring. The season was very severe. The following spring the *Antarctic*, unable to reach Snow Hill Island, was crushed in the ice and lost. In the meantime, the *Uruguay*, a relief vessel which had been sent out by the

Argentine Government, reached Nordenskjöld on November 8, 1903. The same day Larsen appeared in camp with five of his companions and reported the fate of the *Antarctic.*



ANTARCTIC REGIONS

ROUTES FOLLOWED BY OTTO NORDENSKJÖLD, 1902–1903; R. F. SCOTT, 1902–1904; W. S. BRUCE, 1903–1904

It may be of interest to the visitor to know that Mr. Frank Wilbert Stokes, the artist of the mural paintings in the Eskimo Hall, was a member of this expedition.

R. F. SCOTT, 1902-1904

Discovery

[The course, in part, is indicated by diagonal white and red bands.]

The *Discovery*, under Captain R. F. Scott, a new and well-equipped vessel, manned by officers of the British navy and bearing a scientific staff of well-qualified men, crossed the Antarctic Circle in January, 1902, proceeded to Cape Adare, along the coast of Victoria Land, thence east beyond the point reached by Ross, and discovered Edward VII Land. Captain Scott then returned and placed the *Discovery* in winter quarters near Mount Erebus, where the season was pleasantly spent. On November 2, Scott, Shackleton and Wilson began their heroic sledge journey over the polar ice cap to the south, a distance of 380 miles from their ship. They planted the British flag at 82° 17′ S.

On January 25, 1903, Captain Colbeck of the relief ship *Morning* sighted the *Discovery* and, since the latter vessel could not be freed from the ice, stores were left and the *Discovery* party spent its second winter in the Antarctic. The cold was intense—frequently 50° below zero, and even 68°, was registered. During the spring, Scott and his party traveling westerly reached a position on the elevated plateau of the Antarctic Continent 9,000 feet above sea level. On January 5, 1904, the relief ship *Morning* again appeared, accompanied by another and larger vessel, the *Terranova*. For a while it was thought that the *Discovery* must be abandoned, but on February 16 she was released and sailed for home, thus concluding what must be considered an expedition of extraordinary success.

W. S. BRUCE, 1903-1904

Scotia

[The course is indicated by red and blue bands.]

In 1902, the Scotchman, W. S. Bruce, who was in the Antarctic in 1893 and in the Arctic on the Jackson-Harmsworth expedition in 1894–1897, induced certain of his countrymen to provide funds to equip the *Scotia*, a small Norwegian whaler. He left the South Orkneys early in February, 1903, crossed the Antarctic Circle and made extensive soundings. He wintered on the South Orkneys. In January, 1904, additional soundings were begun and, proceeding south, land was discovered in 74° 1′ S., 22′ W. It was named Coats Land, in recognition of support furnished the expedition by the Messrs. Coats, the famous thread manufacturers.

JEAN CHARCOT, 1903-1905

Français

[The course is not indicated.]

Dr. Jean Charcot, anxious because Nordenskjöld had been obliged to spend a second winter in the south, built the *Français* and organized a relief expedition. He met the Argentine Relief Expedition as it was returning with the Nordenskjöld party. Determining, however, that the *Français* should do some Antarctic work before her return, he remained in the South during the seasons of 1903 to 1905, charting the western coast of the islands of the Palmer Archipelago.

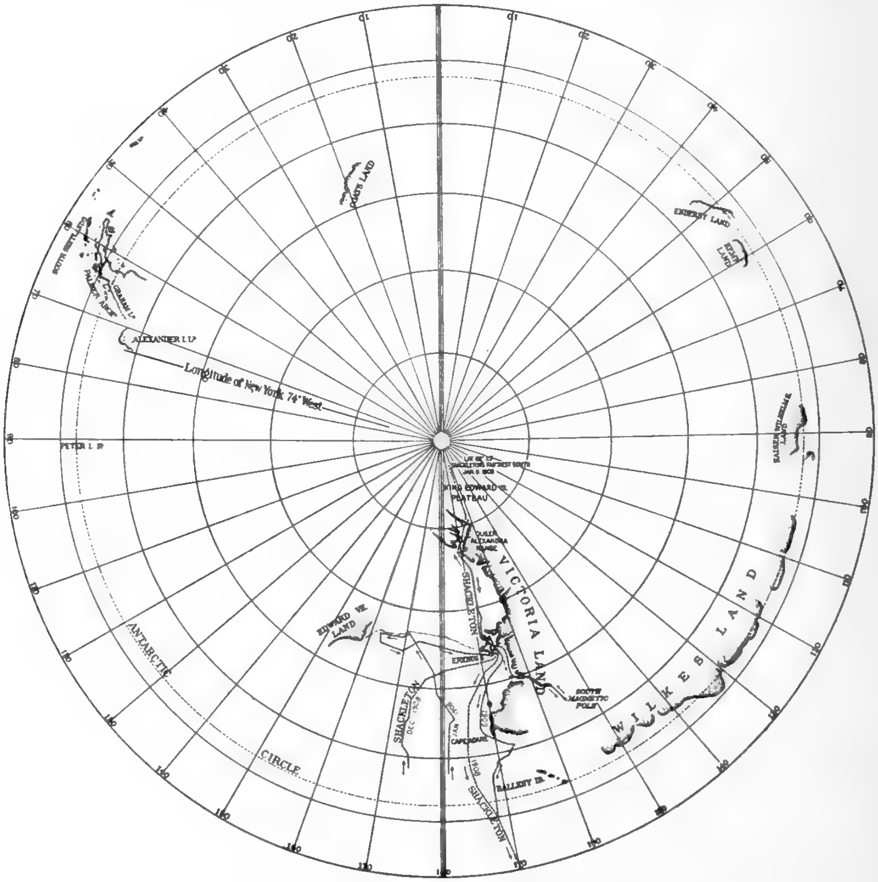
E. H. SHACKLETON, 1908-1909

Nimrod

[The course, in part, is indicated by red, white and narrow blue bands.]

Early in 1908, Lieutenant Shackleton on board the *Nimrod*, with a party of about fifteen men, dogs, Siberian

ponies, a motor car and other equipment, entered the Antarctic regions near the 180th meridian. Passing through Ross Sea and along the edge of the great ice barrier, they almost reached King Edward VII Land, but found further progress in that direction blocked by impenetrable



ANTARCTIC REGIONS
ROUTE FOLLOWED BY E. H. SHACKLETON, 1908–1909

pack-ice. They then proceeded to Cape Royds near the volcano, Mount Erebus. Here the *Nimrod* left them and went north, to return the following spring. Relatively elaborate winter quarters were established at Cape Royds

in a specially designed hut made of cork. In March, 1908, a party of six ascended Mount Erebus to its summit, 13,500 feet above sea level.

On October 5, 1908, a party of five started on its journey to the South Magnetic Pole, which was reached on January 16, 1909. The position of the magnetic pole was determined to be 72° 25′ S., 155° 16′ E. The south point of the compass always turns towards this point. Therefore, between the South Magnetic Pole and the South Geographic Pole the south point of the compass is directed due north. This party, returning to the coast February 3, was picked up by the *Nimrod* and taken to Cape Royds.

On October 29, 1908, Shackleton and three others—with a supporting party of five, which turned back November 7—set out for the South Geographic Pole. They followed, roughly, the 168th meridian east until in late November they reached Scott's farthest south—82° 17′ S. Christmas day found them at 85° 55′ S., and by 9:00 A.M., January 9, 1909, they had reached 88° 23′ S. Beyond this point they could not go on account of the hard traveling and the exhaustion of their food supply. No mountains were visible beyond, and it is probable that the South Pole is situated on a level plateau 10,000 to 11,000 feet above sea level. After an extremely hard return journey on short rations, Cape Royds was reached March 4, 1909. The *Nimrod* and the supporting and relief parties were there waiting, and the next day all started for home.

In addition to discovering the South Magnetic Pole and reaching a point within 110 miles of the South Geographic Pole, the main results of the journey were the finding of coal (showing that in the past this region enjoyed a mild climate), the procuring of a complete meteorological record and the discovery of eight distinct mountain ranges varying from 3,000 to 12,000 feet in altitude.

THE AMERICAN MUSEUM JOURNAL

EDMUND OTIS HOVEY, *Editor*
MARY CYNTHIA DICKERSON, *Associate Editor*
The JOURNAL is published monthly from October to May and sent free to all Members of the Museum

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY.

For Sale at the Museum.

(*Issued as supplements to The American Museum Journal.*)

No. 1.—THE BIRD ROCK GROUP. By F. M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price*, 10 *cents*.

No. 2.—THE SAGINAW VALLEY COLLECTION. By H. I. SMITH, Assistant Curator of Archæology. December, 1901. *Price*, 10 *cents*.

No. 3.—THE HALL OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print*.

No. 4.—THE COLLECTION OF MINERALS. By LOUIS P. GRATACAP, A.M., Curator of Mineralogy. February, 1902. *Revised edition*, May, 1904. *Price*, 10 *cents*.

No. 5.—NORTH AMERICAN RUMINANTS. By J. A. ALLEN, Ph.D. Curator of Mammalogy and Ornithology. March, 1902. *Revised edition*, February, 1904. *Price*, 10 *cents*.

No. 6.—THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By GEORGE H. PEPPER, Assistant in Anthropology. April, 1902. *Second edition*, May, 1909. *Price*, 10 *cents*.

No. 7.—THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. May, 1902. *Price*, 15 *cents*.

No. 8.—THE SEQUOIA. A Historical Review of Biological Science. By GEORGE H. SHERWOOD, A.M., Assistant Curator. November, 1902. *Price*, 10 *cents*.

No. 9.—THE EVOLUTION OF THE HORSE. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition*, May, 1905. *Price*, 10 *cents*.

No. 10.—THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. February, 1903. *Price*, 10 *cents*.

No. 11.—THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price*, 10 *cents*.

No. 12.—THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. October, 1903. *Price*, 10 *cents*.

No. 13.—A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print*.

(*Continued on page 4 of cover.*)

No. 14.—BIRDS' NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted,* February, 1905. *Price,* 10 *cents.*

No. 15.—PRIMITIVE ART. July, 1904. *Price,* 15 *cents.*

No. 16.—THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price,* 15 *cents.*

(*Reprinted from The American Museum Journal.*)

No. 17.—THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1905. *Price,* 15 *cents.*

No. 18.—THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.—THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Price,* 15 *cents.*

No. 20.—THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price,* 15 *cents.*

No. 21.—THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D.M.D. January, 1906. *Price,* 10 *cents.*

No. 22.—THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April-July, 1906. *Price,* 15 *cents.*

No. 23.—THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Price,* 10 *cents.*

(*Published as a separate series.*)

No. 24.—PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price,* 10 *cents.*

No. 25.—PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Price,* 15 *cents.*

No. 26.—THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price,* 10 *cents.*

No. 27.—THE MALARIA MOSQUITO. By B. E. DAHLGREN, D.M.D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Price,* 15 *cents.*

No. 28.—THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price,* 15 *cents.*

No. 29.—THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909. *Price,* 10 *cents.*

No. 30.—THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO. November, 1909. *Price,* 5 *cents.*

No. 31.—A BRIEF HISTORY OF ANTARCTIC EXPLORATION. March, 1910. *Price,* 10 *cents.*

AMERICAN MUSEUM OF NATURAL HISTORY

Trees and Forestry

FLOWER AND LEAVES OF THE TULIP-TREE

PORTION OF MODEL IN THE FORESTRY HALL

NO. 32 OF THE GUIDE LEAFLET SERIES—SEPTEMBER, 1910

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

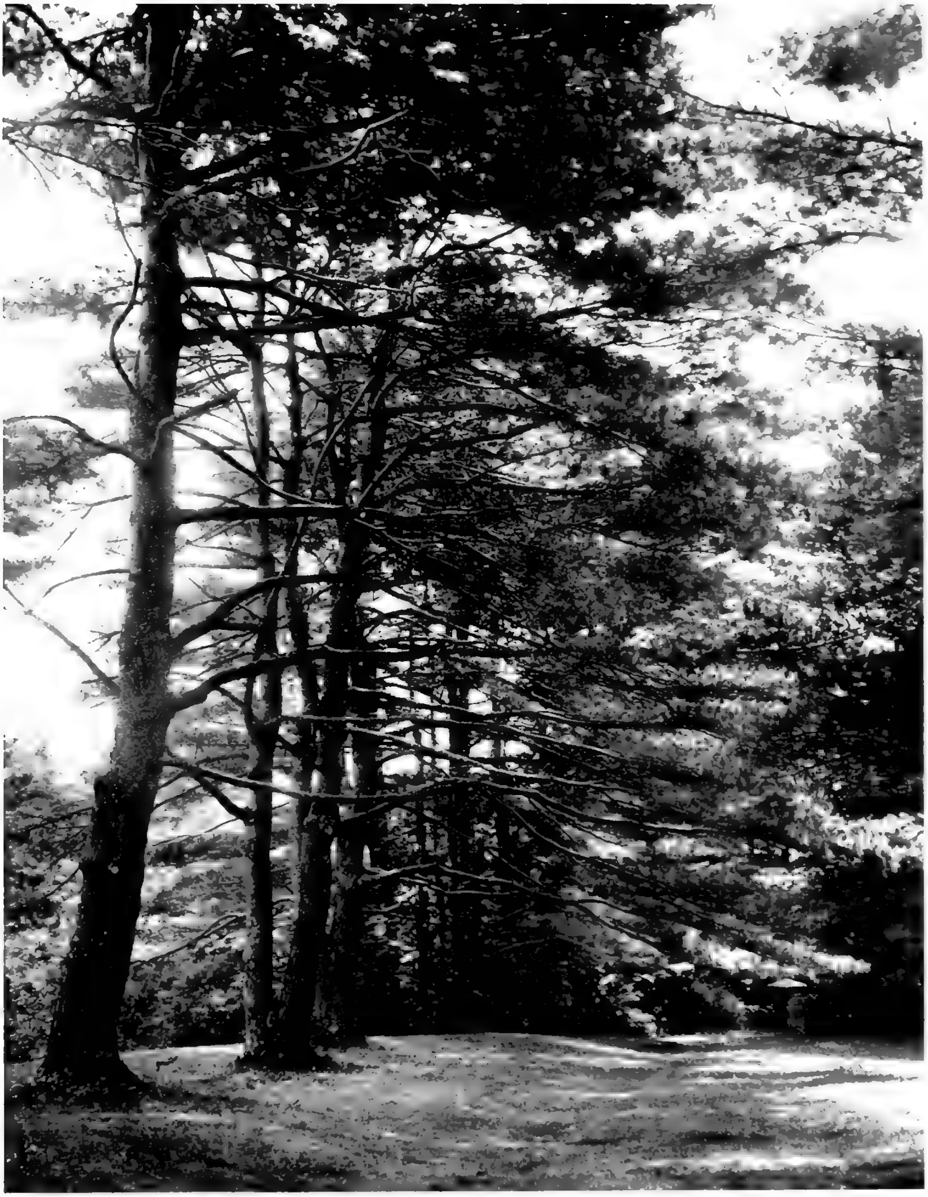
THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members............	$10	Fellows....................	$ 500
Sustaining Members (Annual) .	25	Patrons	1000
Life Members	100	Benefactors (Gift or bequest)	50,000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year.



WHITE PINES

On the estate of the late Morris K. Jesup, Lenox, Massachusetts

TREES AND FORESTRY

AN ELEMENTARY TREATMENT OF THE SUBJECT BASED ON THE

Jesup Collection of North American Woods

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By MARY CYNTHIA DICKERSON, B. S.
Curator of Woods and Forestry

NEW YORK
Published by the Museum
September, 1910

NO. 32

OF THE

GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

MARY CYNTHIA DICKERSON, Editor

CONTENTS

PREFATORY NOTE

The author expresses gratitude to all those who have extended courtesies during the preparation of this *Leaflet*. Especially are thanks due to the Honorable Gifford Pinchot, President of the National Conservation Association and to Professor J. H. Toumey, Director of the Yale Forest School, who as members of the Appointive Committee on Woods and Forestry of the American Museum read the *Leaflet* in proof and gave valuable suggestions; also to the United States Forest Service and Doubleday, Page and Company, who allowed the use of photographs for many of the half-tones. Primarily, of course, indebtedness is due to the Forest Service, since much of the subject matter concerning practical points has been compiled from its work.

The pamphlet has been made to cover a wide field in order not to lack in suggestiveness along the various lines of interest of the Museum's visitors; thus of necessity it touches many matters briefly. Again forestry is so rapid-growing a subject to-day that even a few months are likely to put out of date these briefly stated facts along certain practical lines. The latest information of markets and methods as well as of legislation on conservation at home and trade relations with foreign countries must always be sought in later publications, such as Government bulletins and the monthly periodical of the American Forestry Association.

The chapter intended to help in the identification of trees in their winter condition, although covering trees represented by an armful of twigs which one might gather in the Eastern United States, is so incomplete that it has been given a subordinate place as an appendix. The line cuts for this chapter were made from freshly gathered material, under the supervision of the author, by Miss Alma Field of the Rhode Island School of Design, Providence.

American Museum of Natural History, *September, 1910.*

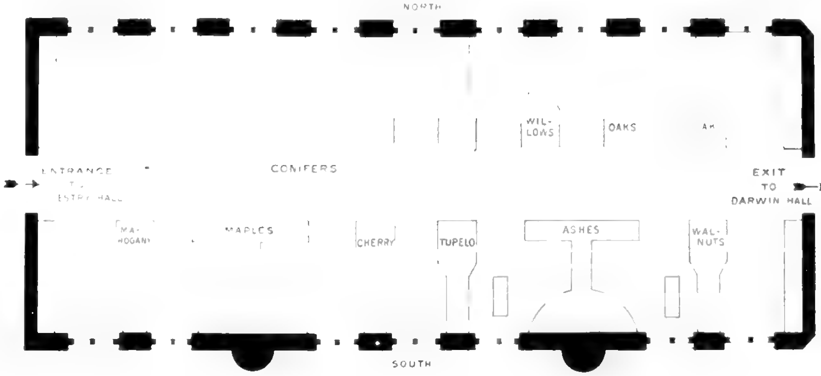


DIAGRAM OF THE FORESTRY HALL, FIRST FLOOR, EAST FROM THE MAIN FOYER
AMERICAN MUSEUM OF NATURAL HISTORY

The Forestry Hall contains the Jesup Collection of Woods representative of the five hundred species of North American trees. These woods are arranged in related groups or families, the specimens of large market value holding prominent place in each group

SOME BOOKS ON TREES AND FORESTRY

BOULGER, GEO. S. Wood. London: Longmans, 1902. $3.00

DAME, L. L. and BROOKS, H. Trees of New England. Boston: Ginn, 1902. $1.50

FERNOW, B. E. The Care of Shade Trees. New York: Holt, 1910. $2.00

Economics of Forestry. New York: Crowell, 1902. $1.50

FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE, Washington.

FOX, W. F. and HUBBARD, W. F. The Maple Sugar Industry. Bulletin No. 59. 1905. Free

GRAVES, H. S. Practical Forestry in the Adirondacks. Bulletin No. 26. 1899. Free

The Woodman's Handbook. Bulletin No. 36. 1903. Free

GRAVES, H. S. and FISHER, R. T. The Woodlot. Bulletin No. 42. 1903. Free

HERTY, CHARLES F. A New Method of Turpentine Orcharding. Bulletin No. 40. 1904. Free

HUBBARD, WM. F. The Basket Willow. Bulletin No. 46. 1904. Free

MCCLATCHIE, A. J. Eucalypts Cultivated in the United States. Bulletin No. 35. 1902. $1.00

PINCHOT, GIFFORD. A Primer of Forestry. Part I — The Forest. 35 cents; Part II — Practical Forestry. 30 cents

ROTH, F. Timber: an Elementary Treatise on the Characteristics and Properties of Wood. Bulletin No. 10. 1895. Free

SHERFESEE, W. F. Wood preservation in the United States. Bulletin No. 78. 1909

SUDWORTH, GEO. B. Check List of Forest Trees of the United States. Bulletin No. 17. 1898. 15 cents

Forest Influences. Bulletin No. 7. 1892. Reprinted, 1902. 15 cents

A Short Account of the Big Trees of California. Bulletin No. 28. 1900. 10 cents

FÜRST, H. The Protection of Woodlands (John Nisbet *trans.*) New York: Jenkins, 1893. $3.50

GRAVES, H. S. Forest Mensuration. New York: Wiley, 1906. $4.00

GREEN, S. B. Principles of American Forestry. New York: Wiley, 1903. $1.50

HOUGH, R. B. Handbook of Trees of the Northern States and Canada. New York: Hough, 1907. $6.00

MARSH, G. P. The Earth as Modified by Human Action. New York: Scribners, 1898. $3 50

PARKHURST, H. E. Trees, Shrubs and Vines of the Northeastern United States. New York: Scribners, 1903. $1.50. (Gives the trees of Central Park, New York)

ROTH, F. A First Book of Forestry. Boston: Ginn, 1902. 75 cents

SARGENT, C. S. Manual of the Trees of North America. Cambridge: Riverside Press, 1905. $6.00

The Silva of North America. Cambridge: Riverside Press, 1891–1902. 14 vols. $350

SCHLICH, WM. Manual of Forestry. London: Bradbury, Agnew. 1894–1902. 5 vols. $17.20

SCHWAPPACH, A. Forestry. New York: Macmillan, 1905. 50 cents

SNOW, C. H. Principal Species of Wood. New York: Wiley, 1903. $3.50

STONE, HERBERT. The Timbers of Commerce. London: Rider, 1904. $3.00

VAN HISE, C. R. Conservation of Natural Resources in the United States. New York: Macmillan, 1910. $2.00

FIG. 1. FLOWERS AND FRUITS OF THE PAPAW (*Asimina triloba*)

Portions of the models in Forestry Hall, Case E, 3. The wine-colored flowers bloom in April; the fruit is ripe in September and October. Wood inferior. Tree planted for ornament

TREES AND FORESTRY

PREPARED FOR USE WITH THE JESUP COLLECTION OF NORTH AMERICAN WOODS

INTRODUCTION

THE Morris K. Jesup Collection of North American Trees, in the Forestry Hall of the American Museum of Natural History, is designed for the student, artisan and forester, and for the man commercially interested in woods, as well as for those who enjoy familiarity with the woodland and wish to increase their enjoyment by extending their familiarity.

The collection was begun by Mr. Jesup in 1880, and throughout his presidency of twenty-seven years, it received his constant attention. Indeed, in its completeness and attractiveness, its scientific correctness and educational value, it is a splendid example of what he desired an exhibition in a scientific and educational institution to be. In its now practically perfected condition, it displays in related groups or families more than five hundred species of the trees of North America. Each tree is represented by a section of trunk 5 feet high, cut lengthwise radially $2\frac{1}{4}$ feet, the cut surface showing the color and graining of the quartered lumber in its natural and polished state (see Figs. 2, 5, 6 and 42). Also for the more common trees, there is a separate piece of the wood which may be handled and tested for lightness, softness, resonance, odor and other qualities.

One of the most remarkable features of the collection lies in its accompanying models of tree leaves, flowers and fruits (see Cover and Figs. 1, 2, 5, 6 and 42). So perfectly are the representations executed that it is often impossible to discover even by careful scrutiny how much may be original and how much reproduced. There are flowers of the decorative magnolias, of basswood interesting to bee keepers, curious fruits of sassafras, persimmon, and Osage orange, autumn foliage of oak, sweet gum and sumach.

This leaflet is designed to accompany the Jesup Collection of Woods, emphasizing its great commercial value by adding practical suggestions for the growth of trees. It presents the status of the forest conservation question in the year 1910.

FIG. 2 FLOWERING DOGWOOD (*Cornus florida* LINN

New England to Florida, westward to Minnesota and Texas. Wood, often called boxwood, unusually heavy, tough, strong and hard, receiving high polish, suitable for use in carving, engraving, turnery and for bearings of machinery; used largely for shuttles in the textile industry. Forestry Hall, Case E, 7

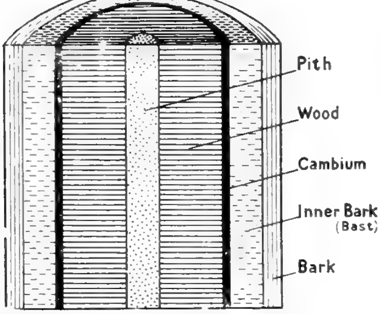


FIG. 3. STRUCTURE OF A TREE TRUNK ONE YEAR OLD

It is a series of cylinders one within another. The cambium is the living part

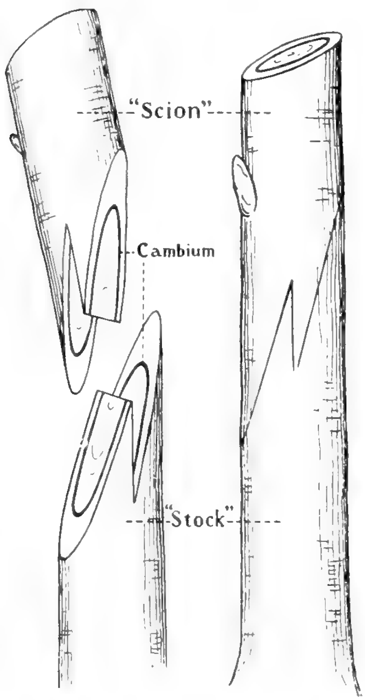


FIG. 4. KEY TO SUCCESS IN GRAFTING

The living cambium of the "scion" must join exactly and become continuous with the living cambium of the "stock," or the process will not be successful

STRUCTURE AND LIFE OF A TREE

A TREE is an individual and as such it is alive, with parts dividing the labor pertaining to life and coöperating for the good of the whole; but, on the other hand, a tree has only a small fraction of its great mass made up of living substance. When very young, it consists entirely of living substance; but long before one year has passed it contains a large accumulation of dead material the great bulk of which is "wood," filling up and making strong the trunk, branches and roots.

The one-year old trunk, examined from the central axis to the outside, has a definite structure as follows: (1) a rod of *pith*, (2) a cylinder of *wood* embracing the pith, (3) a cylinder of *inner bark* (*bast*), thinner-walled than the wood cylinder and embracing it, and outside of these, (4) an enfolding cylinder of *bark* (Fig. 3). All send off parts to right and left into the leaves and, after the first year, into the branches. The living part, called the *cambium*, a living cylinder of scarcely appreciable thickness, lies between the wood and the inner bark. It is easy to understand why, in grafting, the living layer of the branch to be attached must be made to join exactly and become continuous with the living layer of the branch which is to receive it, or the grafting will not be successful (Fig. 4).

Each year this living cylinder of

FIG. 5. WILD PLUM (*Prunus americana* MARSH)

New York to Texas and Colorado. Good stock on which less hardy varieties are grafted. Wood heavy, hard, strong and close-grained. Forestry Hall, Case D, 10

FIG. 6. OSAGE ORANGE, ILLUSTRATING "HEARTWOOD" AND "SAPWOOD"

The formation of the heartwood follows very rapidly on the growth of sapwood so that the latter is only a narrow layer of lighter wood next the bark. The cambium and inner bark are too narrow to be defined in the photograph. Forestry Hall, Case F, 20 (*Toxylon pomiferum* Raf.)

cambium produces new wood everywhere on its inner surface (living material while forming, non-living when formed), a cylinder of new wood enfolding immediately the wood of the year before (Fig. 7). Wood never lengthens after once formed, so a trunk grows in height only by additions from living buds at the top (Fig. 8), but a tree grows in diameter annually by just the thickness of the new cylinder of wood (a ring of wood when seen at the end). The thickness of the annual layer in any species depends on the length of the growing season in the given region and on the age of the tree, those wood cylinders formed in early life being relatively thick-walled and later ones successively more and more thin-walled. A further fact is true, however, and to be remembered in economic tree planting, that the diameter increase of any tree is always immediately dependent on its growing space, on soil, light and other conditions of the surroundings, factors which to a large extent we can control.

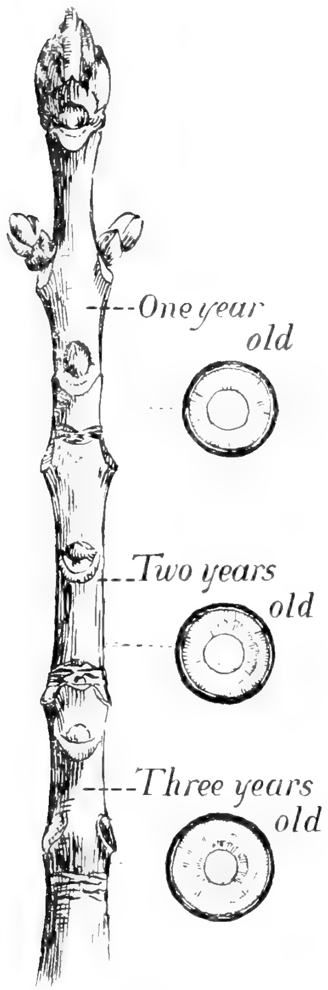


FIG. 7. WHITE ASH TWIG

Cross section to show rings of wood, corresponding to the cylinders of wood in the twig. Compare with Fig. 8

This method of growth places the older wood as "heartwood" in the center of the trunk, while the younger wood, called "sapwood," is outside of this. Heartwood and sapwood may differ in weight and in color, since the heartwood is likely to be a storehouse for coloring matter, or gummy, resinous or mineral substances which have come into the tree from the soil or are the waste from vital processes. Heartwood is more durable than sapwood because it does not often contain starch or other organic matter, and therefore is less liable to the attacks of insects and to the growth of the organisms that cause decay, also on its change from sapwood depositions of material more or less antiseptic take place. Trees in which the formation of heartwood does not follow rapidly on the growth of sapwood are the oaks, elms, walnuts and pines. Some trees

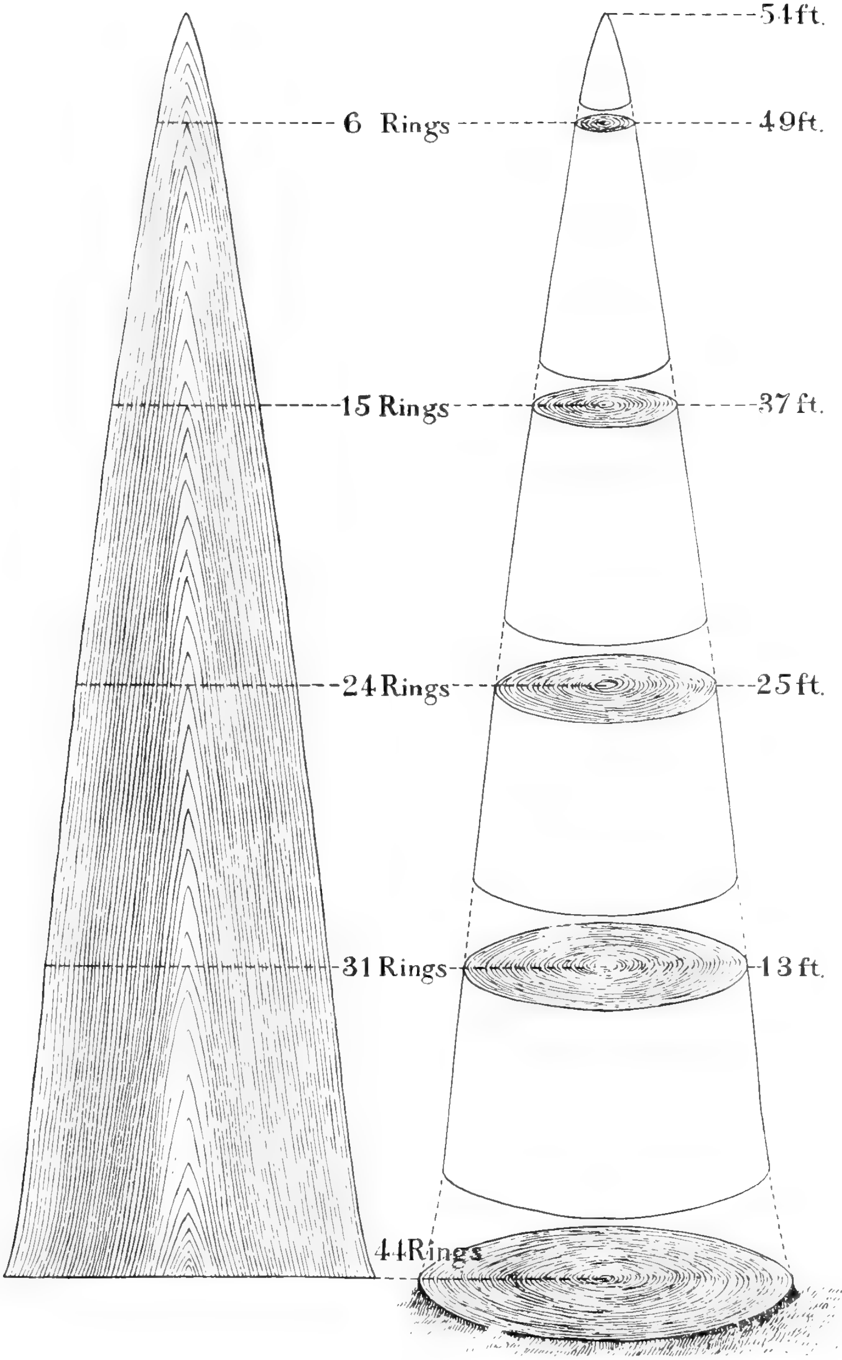


FIG. 8. THE PROGRESSIVE GROWTH OF A TREE

A tree grows in diameter each year by the addition of a cone of wood which never increases in height after being formed. Compare with Fig. 7. The age of the trunk is shown at various heights (44 years at the ground, 6 years near the top, corresponding to the number of rings in cross section)

FIG. 9. CROSS SECTION OF CHESTNUT
Showing the porous "spring wood" and more compact "summer wood"

noted for their narrow sapwood are locust, mulberry, Osage orange (Fig. 6), chestnut and larch.

Also in the wood of each cylinder or ring, there may be a differentiation in color and often in structure, that part of the cylinder which grows rapidly in the spring proving light in color and perhaps porous (spring wood) (Figs. 9 and 10). In fact, it is difficult to count the annual rings in birches, hornbeams, maples, poplars and willows, trees in which so little summer wood is made, that the spring wood of one year appears to adjoin the similar spring wood of the next year.

We speak of the beginnings and additions of wood as cylinders, but, in truth, they are cones, as a consideration of Figs. 7 and 8 will prove. A cut through the central part of a log so that the saw practically cuts through a radius of each cone will produce a board with its surface showing wood bands or lines relatively parallel (Figs. 11 and 13; radial or quartered cut of

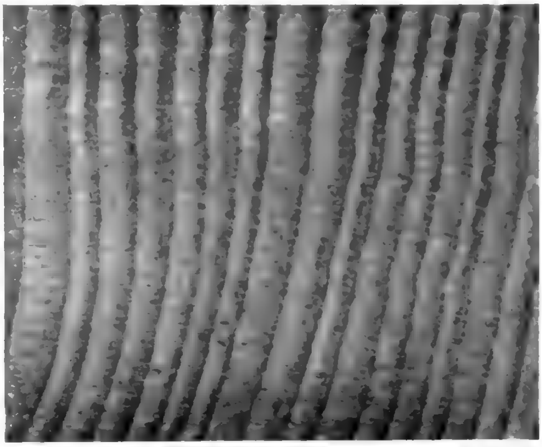


FIG. 10. CROSS SECTION OF DOUGLAS SPRUCE
Indicating variation of spring and summer wood

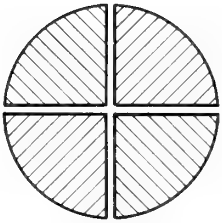


FIG. 11. ONE METHOD OF QUARTER-SAWING

Quartered boards warp and split less than tangential cuts of lumber because cut in the direction of the pith rays. Compare with Figs. 13, 18 and 20

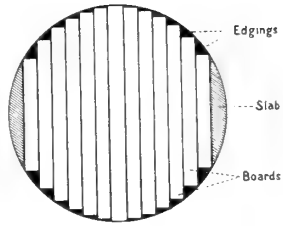


FIG. 12. COMMON METHOD OF SAWING TIMBER

No quartered lumber results, with the exception of a few boards in the middle. There is waste in any method of sawing but charcoal blast furnaces and chemical plants may convert bark, limbs, edgings and even sawdust into some valuable product

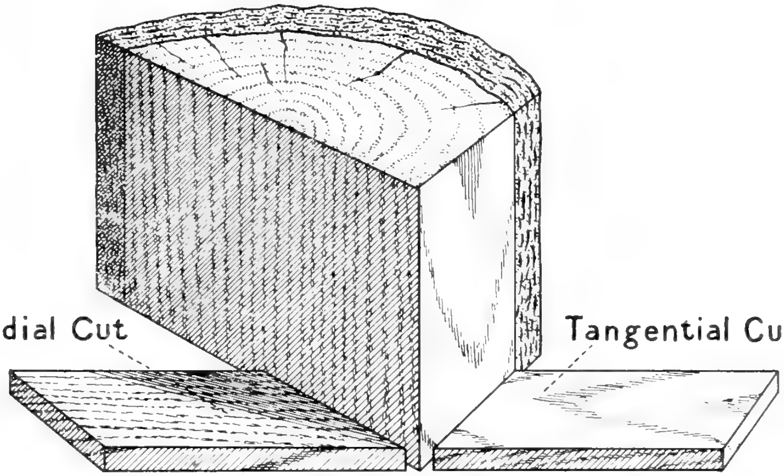


FIG. 13. RADIAL AND TANGENTIAL CUTS OF LUMBER

Boards cut from the central part of a log (and so at right angles to the wood rings and in the direction of the pith rays) produce radial, rift, or quartered lumber; other boards (tangent and oblique to the wood rings and more or less at right angles to the pith rays) give tangential, common, or bastard cuts of lumber. Compare with Figs. 11 and 20

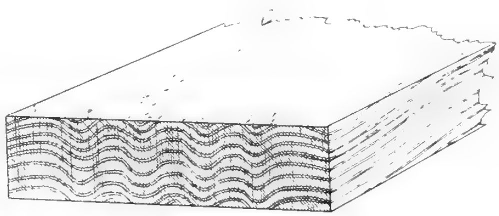


FIG. 14. BIRD'S EYE MAPLE

Occasionally there is a tree in which the wood cylinders have fluted walls. Cutting through these fluted walls produces the "bird's eye" marks on the boards

lumber). In a cut downward through a log some distance out from the center, the saw continually strikes and cuts through the sloping walls of wood cones and the resulting board shows in its midline wood bands appearing as concentric angles or U-shaped figures (Figs. 12 and 13, tangential or bastard cut of lumber). The U-shaped marks may be the result also of irregularity in the growth of the tree due to the effects of sun, prevailing wind or other external agency. Occasionally the wood cylinders for some unknown reason have fluted walls, in which case it is easy to see how a board gains the appearance called "bird's eye," illustrated in hard maple (Fig. 14).

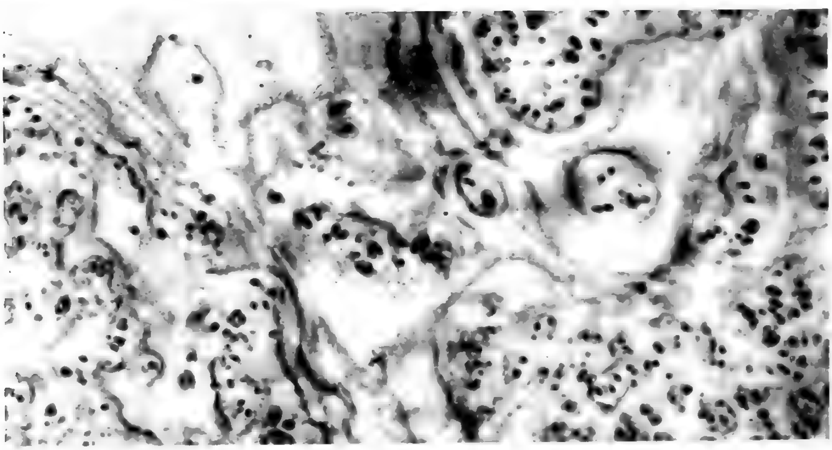


FIG. 15. BLACK ASH BURL

Irregularity of the wood cylinders in burls or knots causes the unusual and often very beautiful effects seen in burl veneers

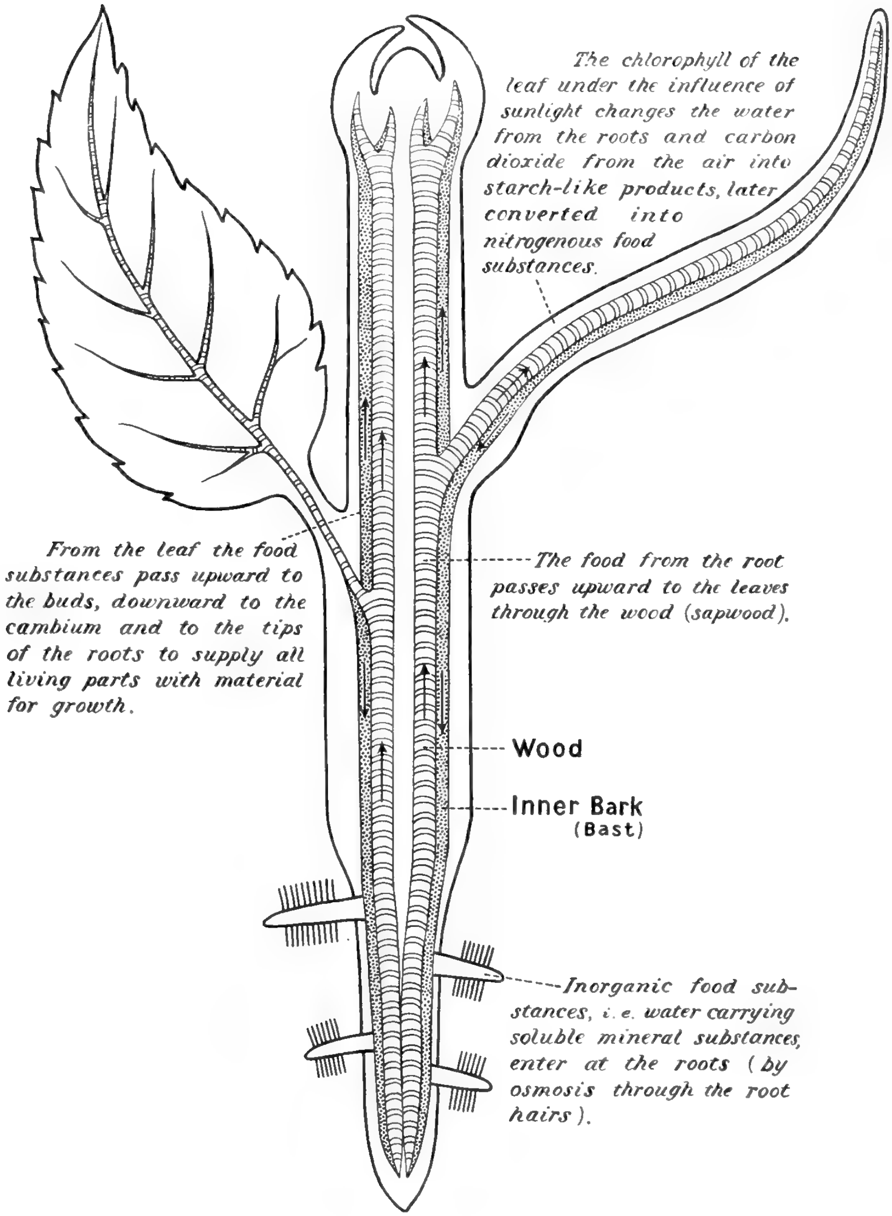


FIG. 16. DIAGRAM SHOWING COURSE OF THE SAP

It passes from the roots through the wood to the leaves, and after its chemical change there, through the inner bark (bast) to all growing parts

Irregularity of the wood cylinders in "burls," overgrown knots and excrescences occasionally found on various trees, causes the unusual and often very beautiful effects seen in burl veneers (Fig. 15).

It is the work of these various tissues in coöperation for the tree's maintenance as an individual that is of most interest. Water containing lime, potash and other minerals in solution, is taken up from the soil through the roots. This food cannot be used directly for growth by the tree any more than it could be by man. It is sent upward through the sapwood to the leaves of the tree. A tree may be girdled, that is, cut to the cambium, and also may be hollow through the whole extent of its heartwood, yet it will live for some time if there is continuous sapwood

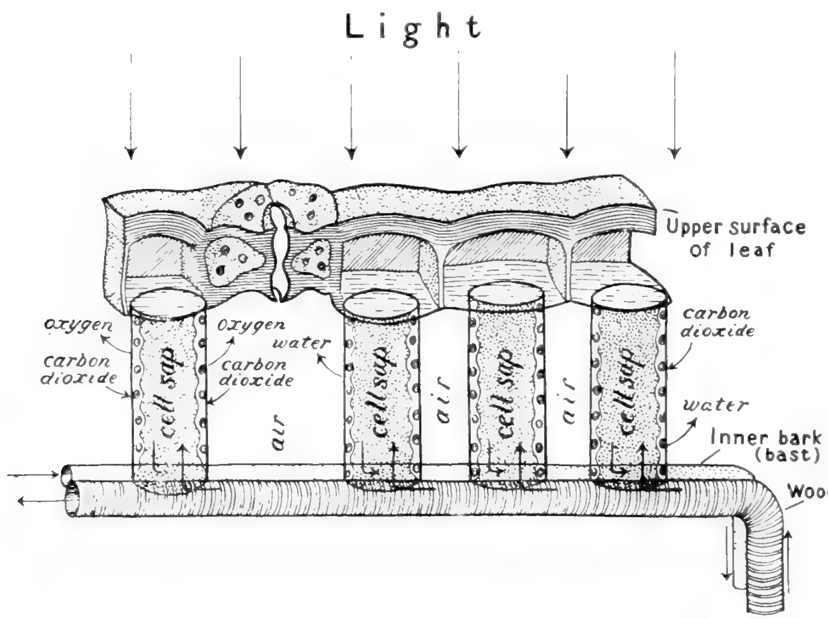


FIG. 17. ACTIVITIES GOING ON IN THE "CELLS" AND AIR SPACES OF A LEAF

(1). Under the sun's heat, water is continually evaporating from the leaf. A tree must lift several thousands of lbs. of water to the leaves to get 1 lb. of mineral matter in solution in the sap. The greater part of this water is evaporated from the leaves. A birch tree gives off 700–1000 lbs. of water daily; a single oak sends off into the air 130 tons of water annually

(2). Carbon dioxide is absorbed continually in daylight by the leaf to make possible the starch-forming process, while free oxygen is at the same time given off as a waste product from this same process. This absorption of carbon dioxide and outpouring of oxygen makes one explanation of the fact that park and street trees increase the healthfulness of a city

from root to leaves. The living green substance (chlorophyll) of the leaves under the influence of sunlight breaks apart the hydrogen and oxygen, elements in this water gained from the roots, and at the same time separates the carbon and oxygen, elements in carbon dioxide gained from the air, and recombines the three, hydrogen, oxygen and carbon, to make various starch-like products. This chemical work of green plants, defying man's efforts to imitate, creates food for animal life on the globe and is, in fact, the only source of that food. Later, the starch is changed to complex substances, largely because of the addition of nitrogen, and passes through the inner bark (bast) of the trunk, upward to give food to the growing buds, downward to supply the living cambium throughout its length with material for a new wood layer, and to give nourishment to the living tips of the roots (Fig. 16).

These plant activities, mechanical and chemical, are not fully understood. Osmosis or the passage of liquids through an organic membrane explains the entrance of water carrying soluble substances into the roots; and since in osmosis the movement is more rapid in the direction of the stronger solution, which in this case is within the roots, the continual passage of water into the roots must create considerable pressure upward. This root pressure accounts in some degree for the rise of water in the trunk. Root pressure in birch trees will lift water in the tree trunk to a height of 84.7 feet. A second force acting to carry the current upward through the sapwood is probably capillarity (the force which causes rise of a liquid through any porous substance). A third force is the strong attraction naturally existing between particles of wood and particles of water. A fourth is certainly the continual and often rapid evaporation of water from the tree's enormous leaf surface which lies spread out under the heat of the sun (Fig. 17).

Other structures of the trunk, complicating an understanding of the appearance of lumber, are short, thin plates made of a substance like the pith, arranged radially and vertically through the wood but irregularly with reference to one another (Fig. 18). These plates, called pith rays, show as radial lines in a cross-section of a log (see upper section, Figs. 19 and 20). They produce what is known as the silver grain of lumber, inconspicuous short lines on the surface of tangential boards because the plates are cut through their length and thickness, but often conspicuous in quartered lumber where, cut through length and width, the plates are sometimes exposed for two or more inches on the board's surface (see lower section, Figs. 19 and 20). The pith rays in different species of trees differ to such an extent that, like the variations of spring and summer wood, they serve to identify different kinds of wood. In oaks the rays are long and

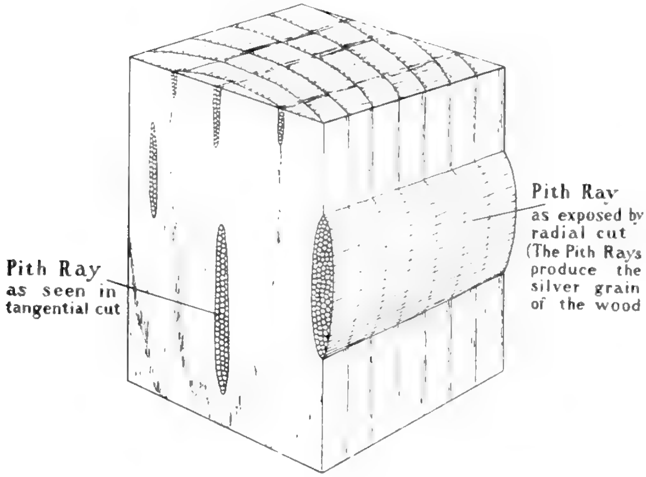


FIG. 18. RELATIVE POSITION OF PITH RAYS AND WOOD RINGS

In a radial cut, the pith rays may show as broad bands (silver grain); in a tangential cut, they appear only as short lines. Compare with Figs. 19 and 20

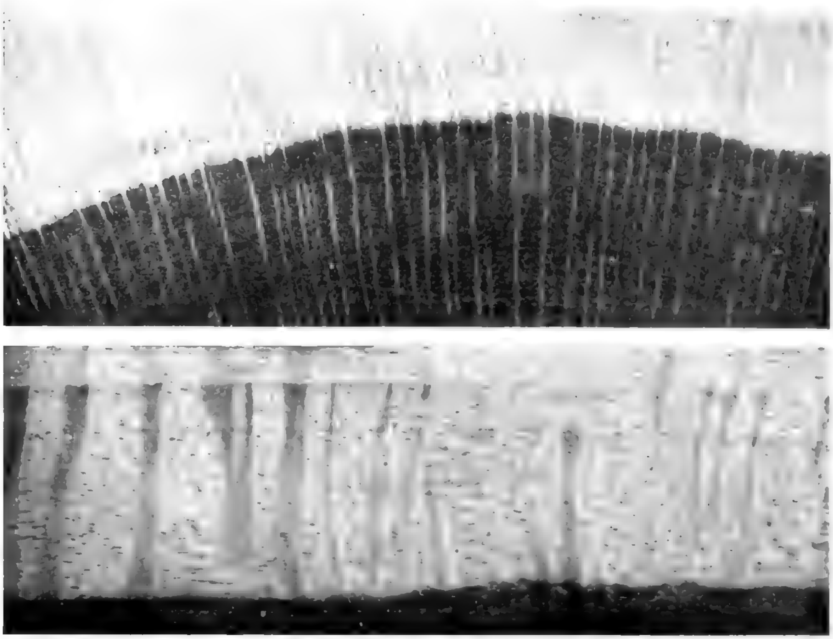


FIG. 19. OAK WOOD SHOWING PITH RAYS

Narrow radiating lines in cross section, broad silvery bands in the quartered wood. Compare with Figs. 18 and 20

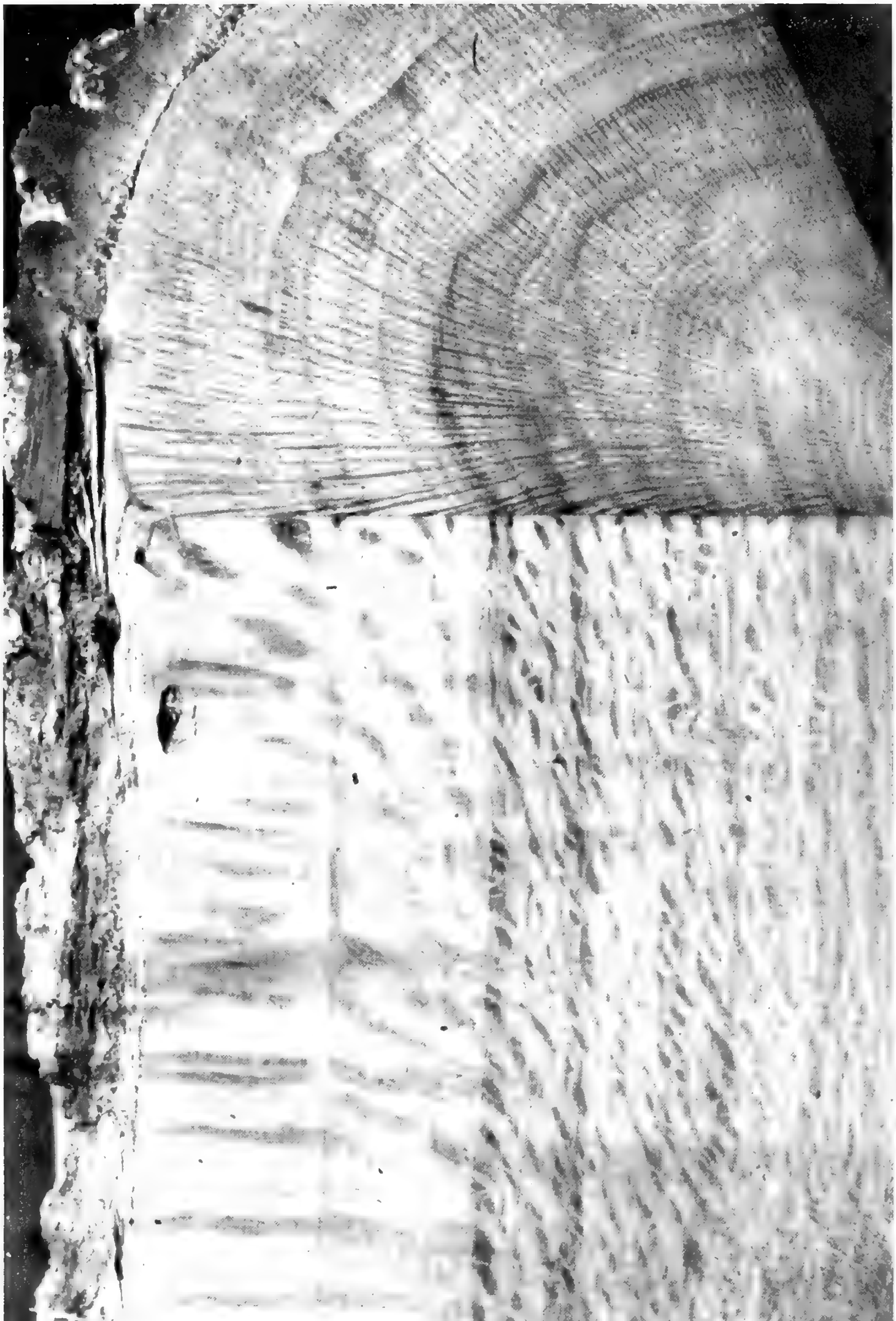


FIG. 20. STUDY OF OAK WOOD

Pith rays of a log seen in cross and radial cuts and at the line of meeting of the two surfaces

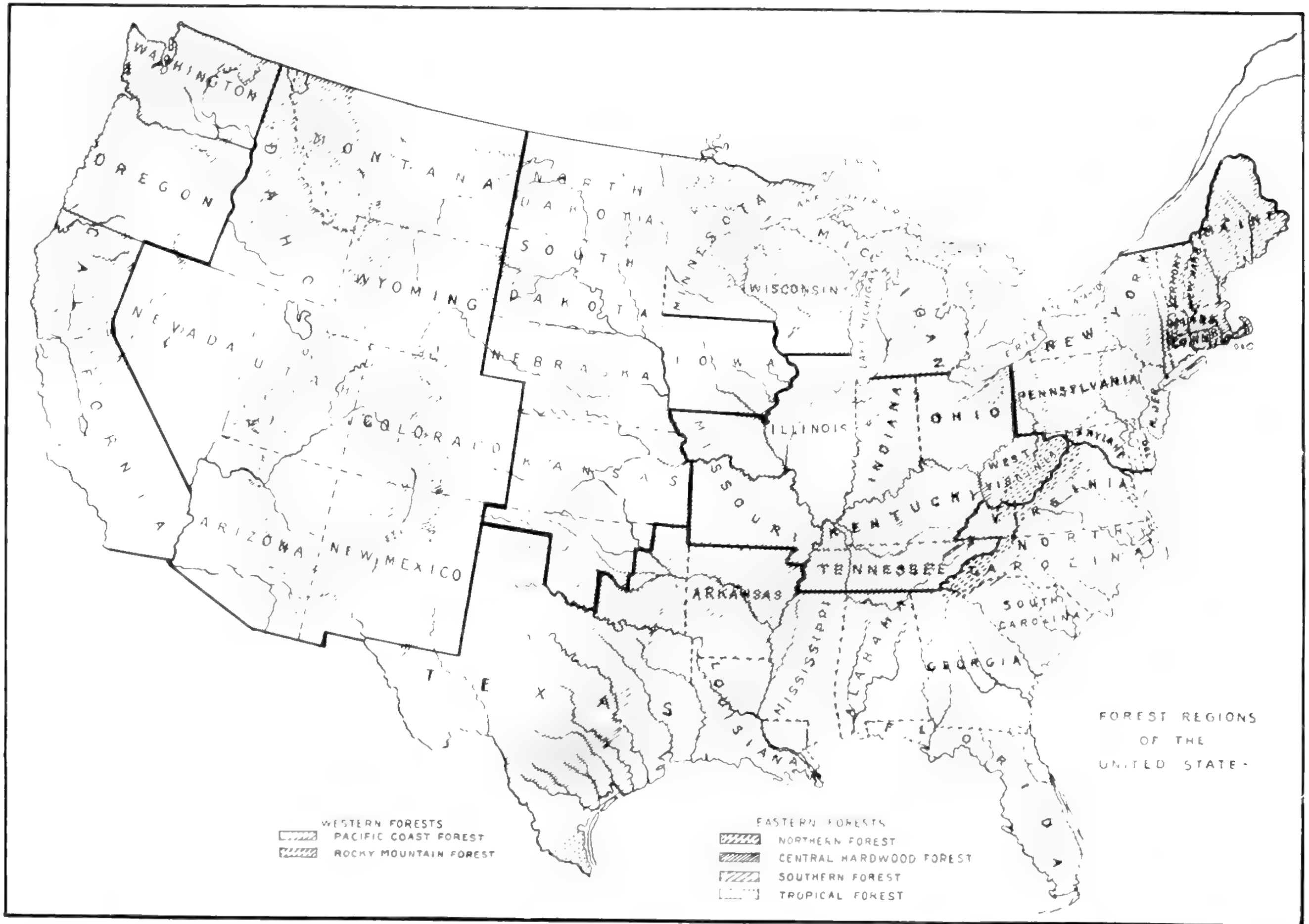


Fig. 21. *Northern Forest* — Spruce, second-growth white pine, hemlock and hardwoods. *Hardwood Forest* — southern portion, hardwoods; northern, cedar, tamarack, hemlock and white pine. *Southern Forest* — Lowest lands, cypress and hardwoods; next level, southern pine; plateaus and lower mountain regions, pure hardwood; highest ridges, spruce, white pine and hemlock. *Rocky Mountain Forest* — Western yellow and lodgepole pines. *Pacific Forest* — Douglas fir, western hemlock, sugar and western yellow pines, redwood, cedar

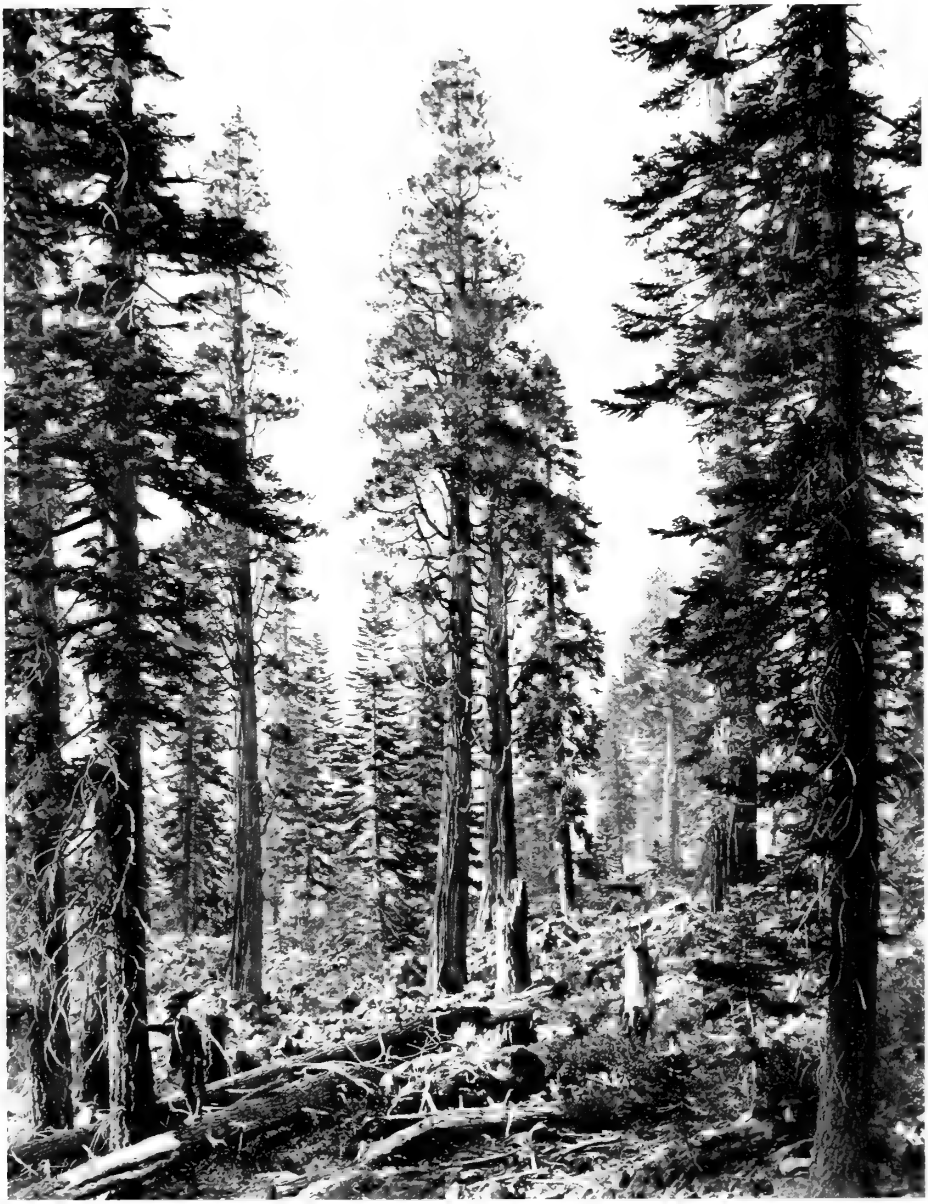


FIG. 22. IN THE PACIFIC FOREST

Virgin growth of Incense Cedar and Red Fir, Siskiyou County, California. (Incense Cedars in the centre, Red Firs at right and left). See colored transparency, Forestry Hall

broad; in maple, elm and ash they are moderately broad; in willow, they can be discovered only by means of a magnifying glass.

The presence of the pith rays proves descent from more primitive trees of much less strength of trunk, their bulk being made up of pith as are the stalks of corn of to-day. Pith rays are lines of weakness in the trunk; especially are they such in the lumber. Boards cut with the pith rays (radial or quartered) are, of course, less liable to warp and split than are those cut across them (tangential).

FORESTS, THE WEALTH AND THE NECESSITY OF THE NATION

ORIGINALLY the people of America possessed great forest wealth which they did not realize exhaustible, wholly ignorant of the country's growth in population and industries. To-day a timber famine is in sight, and there is still far too little realization that this forest wealth is exhaustible; we are destroying annually three and a half times as much wood as new growth adds. Unless all forests from this time on are managed according to some system which will no longer exhaust, but instead, will reconstruct, it is thought that twenty years will see the end of the timber supply in the United States. The original forests covered 850,000,000 acres; at present 550,000,000 acres[1] are forest lands but in large part the trees represented in these forests have only a fraction of the commercial value of those of the primeval forest. (See Figs. 21 and 22.)

An even more impressive view of the situation is given by the following figures, which are averages calculated for the five years previous to 1908, showing the ten countries that lead in the net wood exports and net wood imports respectively:

Countries Selling Wood	Tons	Countries Buying Wood	Tons
Russia with Finland	5,900,000	Great Britain and Ireland	9,290,000
Sweden	4,460,000	Germany	4,600,000
Austria-Hungary	3,670,000	France	1,230,000
Canada and Newfoundland	2,144,000	Belgium	1,020,000
Norway	1,040,000	Denmark	470,000
United States	1,020,000	Italy	420,000
Roumania	60,000	South America	330,000
India	55 000	Spain	210,000
West Coast of Africa	28,000	Egypt	200,000
West India, Mexico, Honduras, etc.	13,000	Holland	180,000

[1] The report of the State Commissioner for January 1, 1910, gives to New York State a holding of 1,841,523 acres of forested land, including 1,530,559 acres in the Adirondacks and 110,984 in the Catskills.

FIG. 23. A SILT BAR ON THE MISSISSIPPI RIVER

A deposit of the fertile constituents of surrounding land. This not only represents the barrenness of the land from which it came, but forms an obstruction to navigation, which must be removed by dredging

Thus it is seen that a large part of the world is getting its wood from Russia, Sweden, Austria-Hungary and Canada. The situation cannot endure, however, for these countries are destroying more forest than they are reproducing. What is in view therefore, is a world-wide wood famine.

Disastrous as a wood famine might prove to the industries of the country, it is not the only result attendant on the destruction of forests. The country faces problems of flood, drought and drying winds, of soils washed of their fertility, streams and harbors unnavigable because of irregular water-flow and because filled with tons of silt from soil erosion (Fig. 23), and all of these problems as well as questions of irrigation depend largely for their satisfactory solution on attention to the country's forests.

That they do thus depend lies in the fact that forests convert the region they occupy into a vast "sponge" for absorbing and holding water. It is said that the Croton Watershed controlling New York City's water supply needs at least 1,000,000 trees planted to husband the rainfall.[1] The

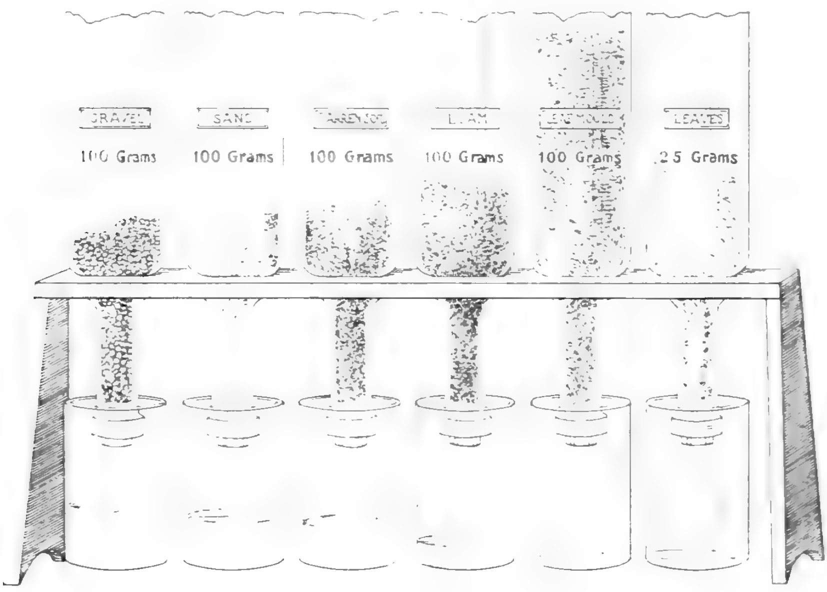


FIG. 24 THE ABSORBING POWER OF VARIOUS SOILS

Diagram to illustrate the relative amounts of water held by various kinds of soil and to show that leaf mould of the forest floor has greatest absorbing power

[1] One of the largest spring water companies in New York State has been reforesting its three hundred acres for several years to protect its springs and maintain the purity of the water and a regular supply. It reports planting 350,000 conifers consisting of larch, arbor vitæ, balsam, hemlock and various pines.

29

FIG. 25. MOUNT JEFFERSON, CASCADE NATIONAL FOREST, OREGON

The melting snows of mountains are absorbed and held by the surrounding forests as in a sponge, to be sent out slowly during spring and summer in an equalized supply to lower levels

FIG. 26. VIEW IN WINTER FROM MT. WILSON

If the forest is cut from foothills, their slopes, no longer protected by it and by a blanket of leaves and humus, must freeze solidly and remain frozen late; therefore, in spring, all the water in melting snow from the mountains flows over and down to lower levels without being absorbed,— wasted in damaging floods

31

FIG. 27. FARMING ON STEEP HILLSIDES

Scott's Creek, North Carolina. The lower slopes were cleared and cultivated till the soil was valueless; now the steep hillsides have been cleared and planted to corn. Soon all fertility will be washed out of the soil and the place will be abandoned. Forests instead of agricultural crops on steep slopes give continued returns while protecting adjoining lowlands from erosion and floods

' sponge" consists not only of the tree tops which form a close roof to keep out sun and wind, nor only of the layers of vines, brush, ferns, moss, dead leaves and humus on the ground (Fig. 24), but especially of the ground itself, which to a depth of many feet is a tangled interlacing of tree roots and of channels where formerly tree roots have been. Through such a forest sponge the water from winter snows and spring rains cannot penetrate rapidly but must gradually find its way to springs and brooks, producing a more or less equalized water supply to the surrounding region (Figs. 25 and 26). On the other hand, if the heads of watercourses are deprived of their forests, they allow the water to rush down the slopes, washing out the fertile constituents of the soil and producing floods in the lowlands,—a prodigality of water followed by lack in summer.

These facts are well illustrated in many places in the Appalachian region. Denuded slopes cleared for agriculture have yielded a profitable return for a few years; then decreasingly valuable because of the rapid eroding of the sloping fields, they served for pasturage a few years longer, then became wholly infertile (Fig. 27). This result in itself seems unfortunate enough, but consider the after-work of the rains that swept down these hillside farms (Fig. 28). It is said that in 1907 the floods from the onrush of one stream of this region (the Catawba River) caused a loss of a million and a half dollars' worth of farm buildings and stock.

Examine reports concerning the region of the Ohio Valley which, like the Appalachian region, possessed some of the finest broad-leaved woodlands of the country. Here farmers fought the forest for generations, regarding it wholly in the light of an enemy because the soil is fertile for agriculture. They cut the chestnuts, the walnut and hickory, the sycamore, elm and poplar, built log houses of the most perfect trees and burned the others. When demands for tanbark came they cut the oaks, sold the stripped bark and burned the logs in festival "log-rollings." At last they have produced a district well-nigh without woodlands, but at what cost! There are "mysteriously heaven-sent" blizzards and spring freshets; streams run almost dry in summer, and hot, drying winds scorch the crops; fruit-growing is continually more difficult. The price of timber has risen in unprecedented manner, while the tanbark supply is decreasing at such a rate, not only in the Ohio region but also throughout the country, that the total product in 1907 was 156,941 cords less than that of 1906.

Fortunately the damage to the nation's forests is not irreparable. Now that the country is known throughout its extent and careful estimates of its timber land have been made, now that the imperative necessity of forested uplands to control water supply is understood, there has come about a

33

FIG. 28. ONE OF THE DISASTROUS RESULTS OF A FRESHET

Sand deposited over alluvial bottomlands in Catawba County, North Carolina. This same flood caused the loss of a million dollars' worth of farm buildings and stock

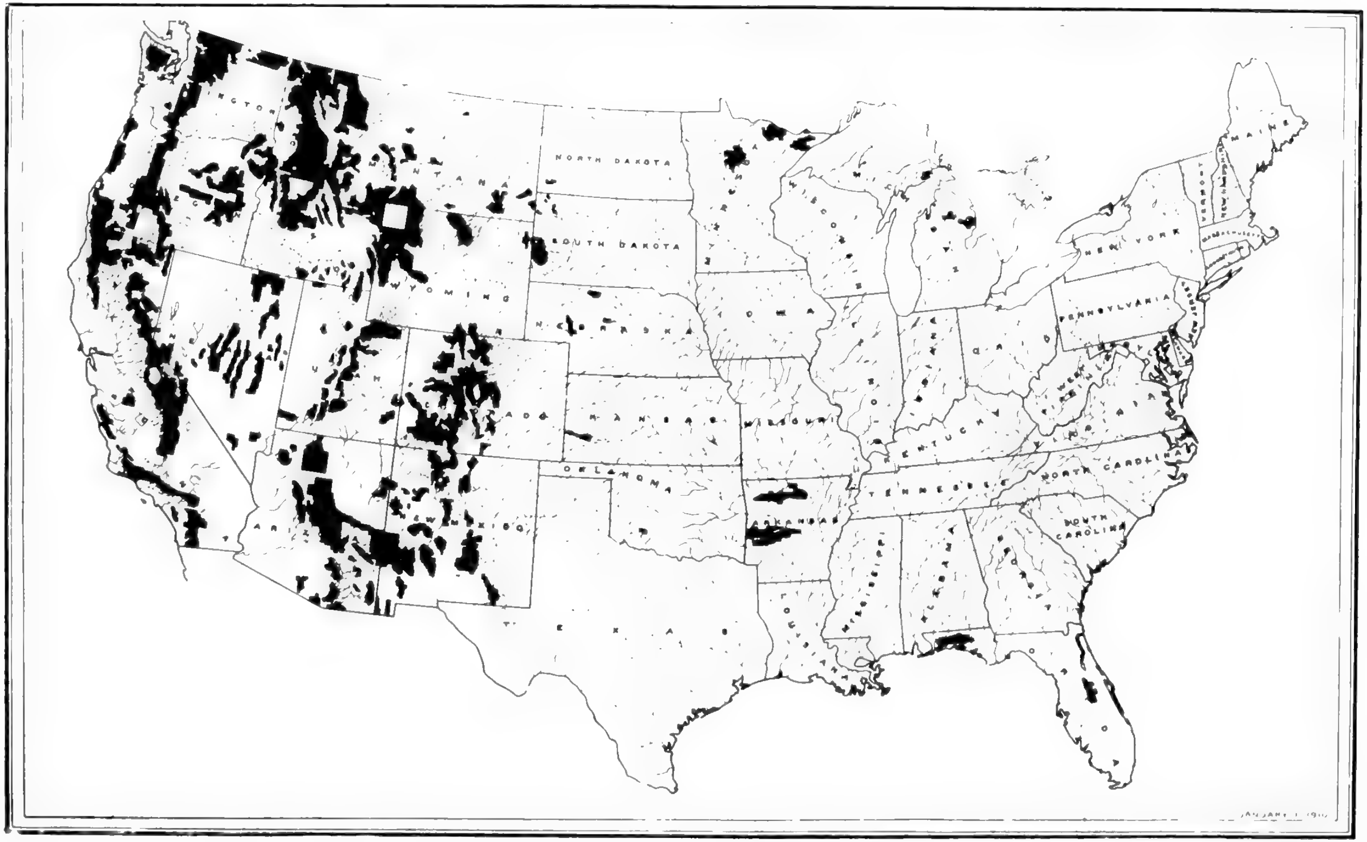


FIG 29. NATIONAL FOREST RESERVES, JANUARY 1, 1910

Before the close of 1910, these reserves reached an acreage of about 196,000,000. For facts concerning the eastern reserves in the White Mountains and Appalachians, see note p. 35

sentiment for united effort in two directions: (1) conservation of remaining forests so that they will be made to yield a product without exhaustion to themselves; (2) reforestation of the heads of watercourses.

CONSERVATION OF EXISTING FORESTS

A LONG step was taken toward the conservation of forests when an act of Congress of March 3, 1891, authorized the President of the United States to set aside from time to time pieces of woodland for the benefit of the American people. Such reserves (Fig. 29), covering an aggregate of about 196,000,000 acres have been made by Presidents Cleveland, Harrison, McKinley, Roosevelt and Taft, and on February 1, 1905, the administration of these reserves was transferred to the United States Department of Agriculture, so that they are now under the care of experts in forestry. That the formation of national reserves is not a sufficient action, that the saving of the forests of the country still depends directly on individual and corporation owners rather than upon the nation, is seen by a comparison of acreage: the total extent of the reserves is one-third of the farm woodland of the country; it is insignificant when listed beside the millions upon millions of acres owned by railroads and by leaders in forest industries.

The work in conservation must be brought about by a coöperation that will result in legislation to bind the Nation, the States, all corporations and individuals. A move in the right direction was made when the Maine Supreme Court decided (March 10, 1908) that a state had the right to restrict the cutting of trees on private land, if the welfare of the general public was endangered by such cutting; also when Louisiana brought before the legislature a similar law, even more definite in its restrictions. By far the most important event in the movement in 1908 was the meeting of the Governors' Conference in May, followed by the joint Conservation Conference in December. Results cannot be obtained except through a union of the States;[1] the forests in Wyoming must be conserved to give

[1] The Weeks Bill·

To enable any state to coöperate with any other state or states, or with the United States for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability of navigable rivers.

This bill, the product of the combined study of some of the ablest men in Congress, is a general conservation bill for the creation of national forests. The immediate interest, however, lies in the Appalachian and White Mountain regions controlling the watersheds of the most important rivers of the East and the South and containing a great part of the timber supply.

The question of reserves for the East has been under discussion for ten years. The Weeks Bill itself has previously passed the Senate three times and the House once. In the sixty-first Congress it again passed the House, June 24, 1910; it was filibustered in the Senate, however, so that Congress adjourned without a passage of the bill. The Weeks Bill is scheduled to come up for Senate vote on February 15, 1911.

FIG. 30. A TRAP FOR FIRE

Clean out dead brush and dead trees and put into a condition to withstand fire

water to the dry plains of Idaho; forests in Colorado equalize the water supply in Kansas; the success of the great irrigation project in Nevada depends on the extent and condition of forests in California. Changes that may come in the near future, wholly to transform the situation, to encourage tree planting and to protect our forests, concern technical points such as taxation of forested land and trade relations with foreign countries.

A question comes from forest owners, "Is the fact that a forest is an investment consistent with conservation?" In answer, experts hold that there are common-sense forestry methods which, if employed in the management of any given woodland, will allow a man to cut his timber now, yet save or grow a better crop for a later harvest; that the value of his investment is increased, for it yields almost the usual immediate profit and a greater deferred gain. That the deferred profit will be great is due in part of course, to the annually decreasing supply of timber and the increasing demand, the yearly consumption at present being more than three times the yearly forest growth. One lumber company estimates that if, when a long-leaf pine forest is cut, twenty per cent of the stand be left, this will yield nearly half the original cut in twenty years,—a two per cent investment if there be no increase in value of timber in the twenty years, a ten per cent investment with the probable rise in value. Many lumbermen who bought long-leaf forests at fifty cents per thousand feet believe that in twenty years these forests will have a value of ten dollars per thousand at least. Dr. C. A. Schenck, formerly forester of the 125,000-acre Biltmore estate in

North Carolina, is quoted as selling white oak at fifty cents per thousand board feet in 1896 and receiving offers of eight dollars per thousand in 1904.

The care and reconstruction which will mean large pecuniary profit to forest owners, varies in different parts of the country and also in different woodlands of the same region, depending on the kinds of trees present, the condition of the forest and the proximity to market. In many cases the advice of a trained forester should be obtained (see p. 67).

SOME FORESTRY METHODS

IF WE enter a tract of forest in the East we are likely to find closely-growing second growths, sometimes chestnut[1] but as often sassafras, ironwood, dogwood, gray birch, red maple and other species of rela-

FIG. 31. LODGEPOLE PINES, 20 TO 25 YEARS OLD

A young forest in need of thinning and cleaning. Bitter Root National Forest, Idaho

[1] Since 1905 great ravages have been made among chestnut trees by a blight or fungus, *Diaporthe parasitica*. The forests of southern New England, of New York and New Jersey have suffered most, the estimate of loss being $10,000,000. So far the fungus yields its hold neither to known remedies nor to those newly tried and threatens to destroy all chestnut trees in the East.

tively small commercial value. There is little sign of the primeval growth of elm, hickory, hard maple, white oak, ash and white pine. Moreover many of these second growths are bent or broken, insect-infested, or burned and decaying at the base. The reforesting has been according to a wasteful and slow struggle for existence. It is possible that eventually the trees

FIG. 32. FOREST AT NEMO SOUTH DAKOTA

Cut stumps low and obliquely to shed rain. This will do much toward ridding the forest of breeding places for insects.

Americans no longer cut off an entire crop of 100 to 200 years' growth with no care for future crops. The problem is to bring a forest to its fullest producing capacity

dominant in the original forest might creep in and displace these, but the result would be a matter of many years. To turn such woodlands into profitable investments is the problem of their owners. Yet scientific forestry to-day is reported in practice on only seventy per cent of publicly owned forests of the United States, and probably on less than one per cent of those privately owned.

Certain fundamental suggestions are applicable to woodlands of any kind or size in any part of the country.

1. Clean out dead brush and dead trees, utilizing this material before it is wholly wasted, and also leaving the forest in a condition better to withstand fire (Fig. 30). Cut out insect-infested trees.

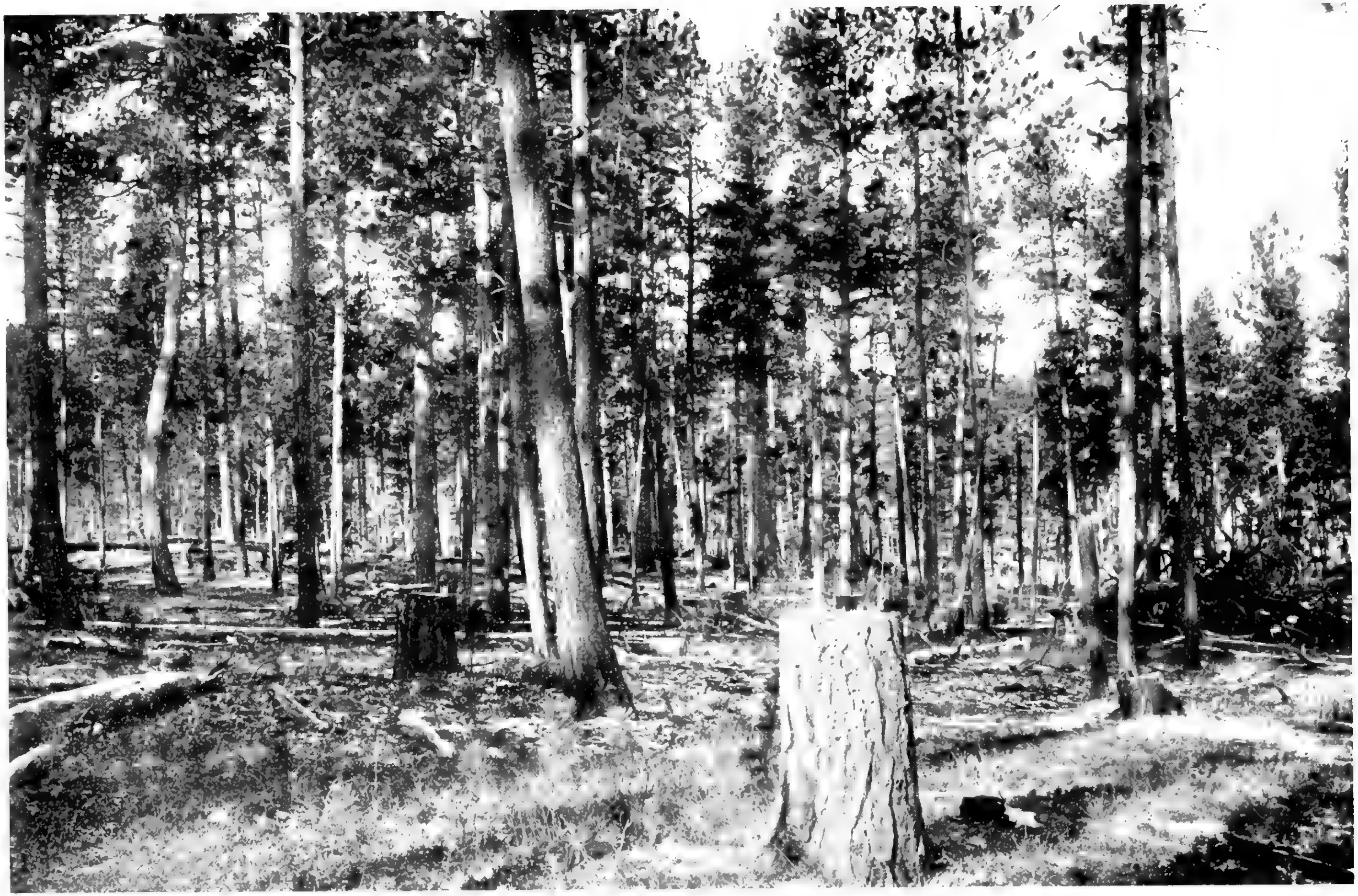


FIG. 33. WASTE IN CUTTING

Material left for insect breeding places and for fire. Black Hills National Forest, South Dakota

FIG. 34. PREVENTABLE WASTE

Fire lessens the productive capacity of soil and may set back young growth for a century or more

2. At the same time thin the forest to let in light and air (Fig. 31); leave the most promising trees (some for seed trees); cut out undesirable species, old trees no longer growing, spreading trees that overtop others of value, and perhaps, trees that grow slowly or that never attain large size. Thin only to such an extent that the crowns of the remaining trees will meet in three or four years; if greater thinning is resorted to, reforest in the open spaces, if only to prevent growth of grass and shrubs and drying out of the humus.

3. Cut all stumps obliquely to shed rain, also as low as possible (Figs. 32 and 33). These precautions will do much toward ridding the forest of breeding places for insects. See p. 63 in regard to sprout growth from stumps.

4. In cutting and removing trees avoid injury to the seedlings and young trees. This is one of the most difficult and imperative of forestry laws.

5. Protect from grazing and from fire (Figs. 34 to 37).

If used for grazing, a wood lot rapidly decreases in reproductive power, for cattle or sheep are certain to destroy the seeds and seedlings of the ground as well as the trees of a few years' growth. If the woodland occupies a hillside, animals do much injury by loosening the herbage that holds the soil in place.

Forest fires have increased in frequency and destructiveness till they

FIG. 35 BURNED AND WINDTHROWN TIMBER

A hint of the terrible fire havoc in the Bitter Root Mountains, Idaho, 1910

11

demand national attention. Each new one of large proportions proves a national calamity. Conservatively estimated, the loss to new forest growth amounts annually to $90,000,000, leaving out the $50,000,000 waste of mature timber as well as the loss due to decreased fertility of the forest floor.

FIG. 36. FIRE IN VIRGIN WHITE FIR

Prattville, California. The problem of insurance of forest property at rates no prohibitive must come up for settlement in the near future

In case of large and isolated tracts of land, forest rangers must be employed;[1] in smaller woodlands, fire lanes, constructed to divide the forest

[1] Systems of telephone lines connected with outlooks have been found to facilitate greatly the work of these rangers.

Secretary of Agriculture James R. Wilson has signed an agreement with the Great Northern Railway Company and with the Northern Pacific Railway Company by which in the future the Forest Service and the railroads will coöperate closely in preventing fires in national forests adjoining the tracks of these companies.

into small tracts, will prevent the spread of a fire to disastrous proportions; everywhere and at all times care must be taken to prevent the starting of forest fires from camp fires and burning brush.

The aim of all such work is the improvement of the woodland, although there may result a considerable product for home use and sale. Such improvement, made even at odd times by a farmer without help, has been known to increase the value of the wood lot forty per cent. When the aim of a given cutting is a large product for market, still the forest should be left in an improved, undepleted condition, the cutting accompanied by reforesting. For this cutting and attendant reforesting, few general laws can be made. The method most practicable is the so called "Selection Method" by which selected trees here and there are cut, the owner always keeping in mind the kind of forest he wishes to have after the crop is removed. He must consider the trees remaining as to age, condition, tolerance for shade and market value of species. Sprouts or seedlings from near seed trees will soon fill up the opened spaces; or better still, young trees raised in seed bed and nursery may be planted and so the species fully controlled. By this method a very irregular mixed forest results, with trees of many sizes and kinds, capable of yielding varied products (see p. 52). Trees tolerant of shade (beech, maple, spruce and hemlock) can be made to fill in below

FIG. 37. DISASTROUS RESULTS OF FIRE

Although occurring twenty years ago, the fire has been followed by no young growth. Bighorn National Forest, Wyoming

those not shade-enduring, such as oak and hickory. The greatest difficulty in the management of a selection forest consists in not injuring young trees when getting out a crop.

If a forest consists of trees of relatively even size and age the "Strip" or the "Patch" method may be followed, in accordance with which one portion is cut clean each year. Of course, if a forest is to yield equalized annual incomes, it must consist eventually of as many sections, varying in ages from seedlings to the marketable size, as it requires years for the trees to attain marketable size. For instance, to yield annual crops of box-boards cut from white pine trees of thirty-five years' growth, a forest must consist of thirty-five sections; to gain annual crops of railway ties produced from catalpa trees fifteen years old, the plantation must have fifteen sections.

AIM OF WOOD LOT OR FOREST

THE aim of the wood lot or forest will be determined on (1) its conditions as to species and soil and (2) on the present and probable future market.

Soft Woods in Proximity to Pulp Mills

It is fortunate if a forest of soft woods (balsam, hemlock, spruce, Carolina poplar, aspen, cottonwood, willow, basswood, or tulip-tree) has a near market in the shape of a pulp mill. In 1907 there were used in the United States for the manufacture of paper pulp, 3,962,660 cords of wood, more by 300,000 cords than in 1906. Of this amount 2,700,000 was spruce wood, one-third of which came from Canada.

Trees for the pulp industry must be grown close together so that the trunks will be clear of branches, because first-grade pulp wood, which may bring as high as $10 per cord, is free from knots. Since a pulp mill uses very small pieces, even as small as 2 ft. by 4 in., much of the material taken out in thinning a woodland may be sold to advantage. Experiments in the future may prove that paper can be made from still cheaper material than wood, perhaps from annual plants of rapid growth, cornstalks or the stems of other tall grasses. Here, as in all questions of agriculture and forestry, landowners must study the markets.

In the case of pulpwood, it is especially true that conservation means not only maintaining a supply of raw material but also operating economically in the use of this supply. Timber waste must be used as pulpwood, clear logs sent to the sawmill and slabs, tops and imperfect trunks turned into pulp. This economy is forced upon us, particularly since Canada to protect

her own resources prohibited the exportation of unmanufactured wood (May 1, 1910).

Durable Woods, and Market for Posts

If conditions combine a market for posts and a woodland of durable woods such as cedar, white oak, Osage orange, catalpa, black locust, chestnut or mulberry, cypress or redwood (see p. 47 for treated woods serviceable for posts) the production of posts may be the aim, with reforesting by the sprout method (see p. 63) to gain rapid growth and frequent crops. It is the heartwood only that makes a durable post, so trees must be allowed to attain a diameter that will give a preponderance of heartwood, and naturally the best trees for the purpose are those in which the formation of heartwood follows rapidly on the growth of sapwood (see Fig. 6, p. 13). Reports from Ohio recommend honey locust for posts; if grown close in a good soil, it is said to produce straight, smooth posts more durable than even cedar or white oak.

Durable Woods, and Market for Ties, Poles or Piling

The cutting of durable woods may be deferred until the trees attain a size suitable for railway ties (trees 12 to 16 inches in diameter; also the upper logs of larger trees). About sixty per cent of all ties in use at present are white oak, but the white oak supply is now practically exhausted. In the Lake States hemlock and tamarack are being used. Chestnut sprouts reach size for railway ties in thirty-five years. Every mile of railroad requires 2500 ties and if these ties must be replaced every seven years, as previously, the demand means cutting clear one-half million acres of forest annually. It is reported that the Pennsylvania Railroad uses 620,000,000 ties in its system. This corporation has begun planting trees for production of its own ties; 3,482,186 trees have been set out; 290,000 seedlings were imported in 1908. More than 1,000,000 trees were planted along the railroad's right of way in 1909. The species are black locust, red oak and catalpa, also various conifers such as Scotch pine, white pine and Norway spruce. (See wood preservation, p. 47.)

If durable woods are allowed to grow until they cut logs 25 to 30 feet long (upper diameter 5 inches or more), they find sale as telegraph or telephone poles with a market value of from two to ten dollars per pole.

Chestnut poles may be grown in 42 years from sprouts and will give 12 years' service. Red cedar, which combines more valuable qualities for poles than any other wood, must pass out of use with the present supply since the posts are cut from trees 90 years old and last only about 15 years. Arborvitæ also is one of the most desirable timbers for poles but, like cedar, can be depended on only till exhaustion of the present supply since the tree is

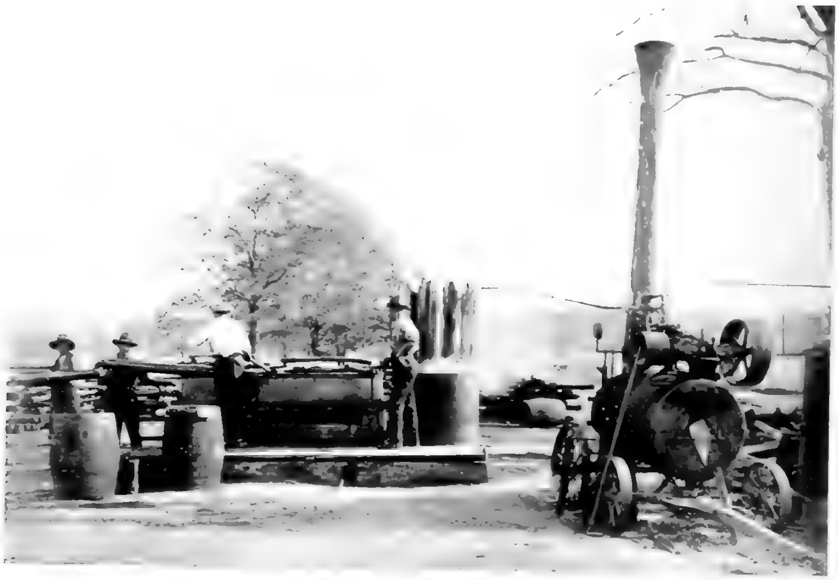


FIG. 38. "OPEN-TANK METHOD" IN WOOD PRESERVATION

Experiments have proved that treatment of wood in a preservative fluid (coal-tar creosote) makes it resist decay in moist situations. This fact will revolutionize the market for posts, poles and railway ties

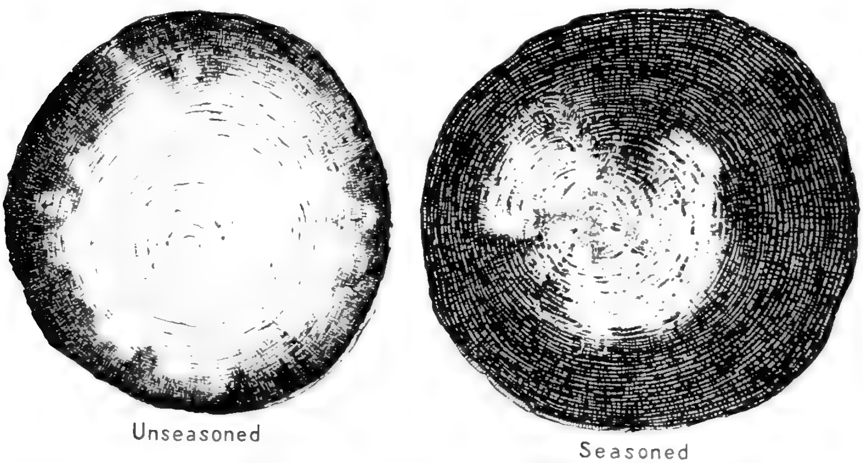


FIG. 39. COMPARATIVE SATURATION IN UNSEASONED AND SEASONED POLES

A partial vacuum must be created in the wood before the preservative fluid can be forced in; and since air can be expelled much more readily than water, seasoned timber is more effectively treated than green

extremely slow in growth. For piling, long-leaf, short-leaf and loblolly pine, white and red oak are used on the Atlantic Coast and the Gulf of Mexico, while Douglas fir supplies the demand in the Pacific region.

Under the waning supply of durable woods, experiments have been in progress which prove that the power of posts, ties, poles, mine and wharf timbers to resist decay in moist situations may be greatly enhanced by treatment in a preservative fluid. So successful has been the work that it is likely to revolutionize the market as regards these products. By treatment, not only do the durable woods gain a lengthened period of service but also less durable woods may be made to take the place of durable woods. The United States Forest Service states the following concerning fence posts: "Resistance of all treated posts to decay is alike, regardless of kind of wood used; posts with much sapwood take a deeper impregnation of the preservative." This means that the cheapest, least durable woods, like poplars, will come into service for posts, leaving the durable woods for use in interior finish and cabinetwork. According to the open-tank method of treatment (Fig. 38), formerly given the highest recommendation by the United States Forest Service, the wood is kept immersed in coal-tar creosote for a number of hours, depending on the kind of wood, and is then plunged into cold creosote, or is left in the cooling preservative over night. The wood should have been previously seasoned (Fig. 39) and its sapwood should be saturated with the oil. Brush treatment, by which the wood is painted with hot creosote, is less expensive, but also less effective because of the slight penetration by the oil (Fig. 40). Treatment in closed cylinders under pressure, is considered the best method as far as results are concerned, but it is five times as expensive as the tank method.

The effectiveness of the tank treatment lies in two facts, namely, (1) creosote oil protects the wood from the entrance of water and (2) creosote — being antiseptic — protects the wood from the attacks of bacteria and various fungi which grow rapidly in damp situations and whose growth means decay of the wood. The theory that insures the impregnation of the wood by tank process is as follows: heating in the creosote expands the air contained in the wood until much of it is driven out; plunging the wood into cold preservative causes the air left to contract leaving a partial vacuum which is filled at once by the cold oil forced in by atmospheric pressure (also by capillarity).[1]

Treatment of wharf timbers with creosote protects absolutely from marine borers (Fig. 41). Zinc chloride is used to some extent in treatment of woods but the resulting protection is not permanent because the preservative is soluble in water.

[1] The importation of 25,000,000 gallons of creosote into New York City in 1908 was an increase of 21,500,000 gallons over that of 1904. This indicates great development of wood preservation.

FIG. 40. BRUSH METHOD OF TREATMENT

Cheaper but far less effective than a saturation method

FIG. 41. DESTRUCTION BY MARINE BORERS

Piles at Norfolk, Virginia. Treatment of wharf timbers with creosote protects absolutely from such attacks

FIG. 42. BLACK WALNUT (*Juglans nigra*)

New England to Florida, Michigan to Texas. Wood hard, susceptible of a high polish, prized for cabinet work and interior finish. Forestry hall, Case G, 7-8

FIG. 43. VALUATION SURVEY AT WASHINGTON, D. C.

Foresters can estimate not only the amount of saw timber in a forest but also the posts, ties, poles and firewood over and above this timber. Conservation means utilization of the whole tree

FIG. 44. GUMPICKER'S CAMP

Spruce woods near Barneveld, N. Y. Gum gathered from the trunks of spruce trees is a paying by-product of the northern forest

FIG. 45 SUGAR MAPLES AT BURLINGTON, VERMONT

Maple trees may be tapped for maple sugar and still yield good timber.

Hardwoods and Cooperage

White oak and elms have been the standards for cooperage work which, like tanbark, entails great waste of material. Coopers have been forced into using beech, red oak, maple, ash and birch, especially for slack cooperage (barrels for dry materials). Logs grown for cooperage should be more than ten inches in diameter. Their market prices are unusually good.

Beech, Maple, Birch, and Acid Factories

In certain eastern districts acid factories demand large supplies of wood for distillation, preferably of beech, maple and birch (8000 cords per year). Some of the products of these factories are wood vinegar used in dye works; wood alcohol of special value in chemical works; acetic acid utilized as vinegar; and charcoal.

A Timber Forest and its Varied Products

If a woodland consists, or can be made to consist in the future, of valuable trees grown for timber from the seed, the owner can well make his aim the production of saw logs for quartered and other high-priced lumber which will find ready sale in home or foreign market. A timber forest may have a wood capital twenty-five times as large as that of a sprout forest. Some of the most valuable timber trees are black walnut (Fig. 42), black cherry, white oak, white ash, hickory, red oak and sugar maple. In a timber forest the distance of trees from one another is an important item: if too far apart, the trunks do not clear well and the lumber is knotty; if too close together, the trunks remain too small in diameter.[1]

A timber forest may yield many products besides high grade lumber.[2] A forester can estimate not only the saw timber in the trees to be cut but the number of posts, ties, poles and firewood over and above this timber (Fig. 43). More and more the entire timber is being used, proving one of the most effective methods of conservation. This complete utilization has been made possible by the establishment in many localities of charcoal

[1] See "Rules and Regulations for the Grading of Lumber," Bulletin 71, Forest Service, U. S. Dept. of Agriculture

[2] The following figures are of interest:

The United States uses annually	100,000,000 cords of firewood
	40,000,000,000 feet of lumber
	1,000,000,000 posts and poles
	118,000,000 railroad ties
	1,500,000,000 staves
	133,000,000 sets of heading
	500,000,000 barrel hoops
	3,000,000 cords of native pulp wood
	165,000,000 feet of mine timbers
	1,250,000 cords of wood for distillation

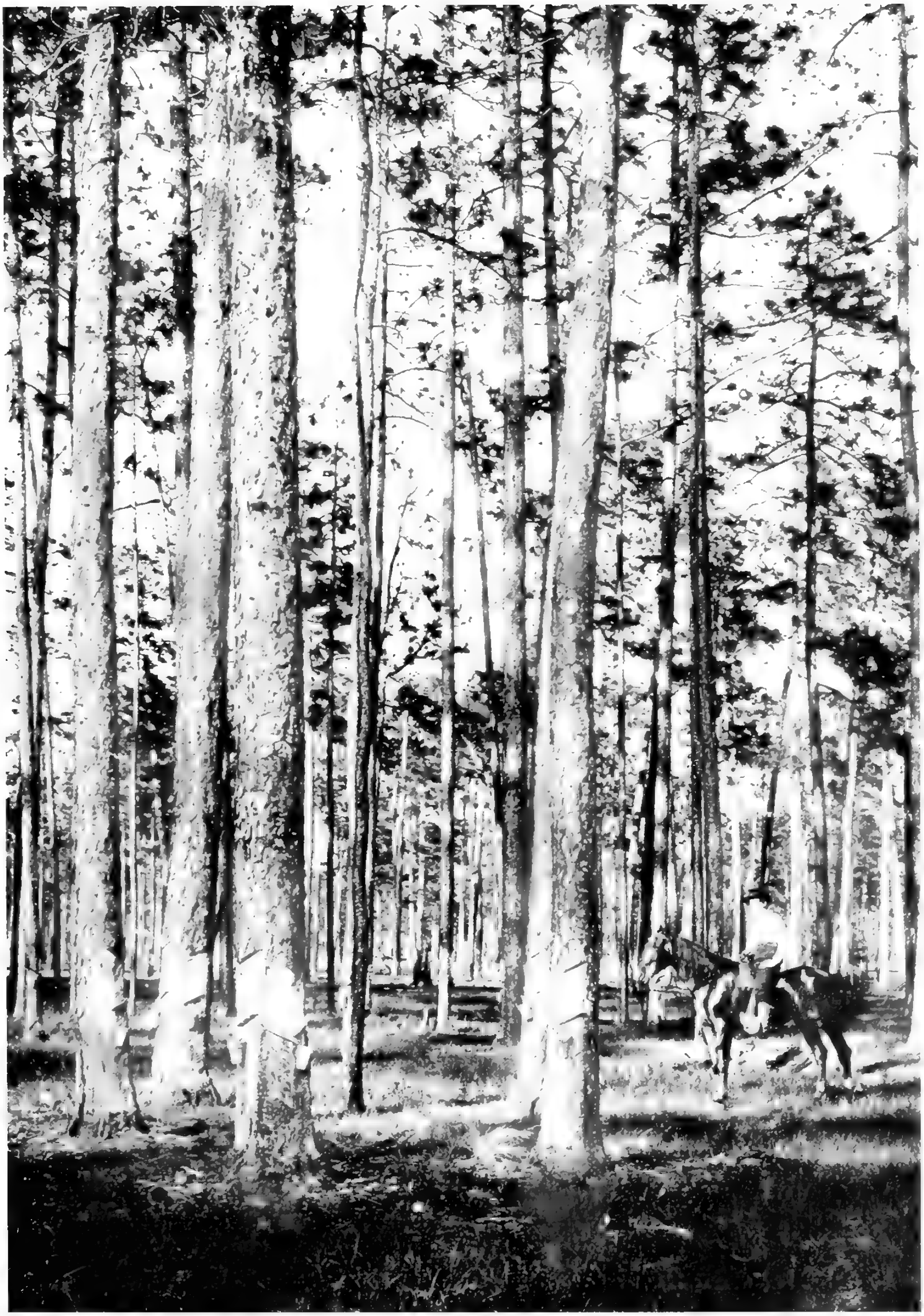


FIG. 46. TURPENTINE FOREST OCILLA, GEORGIA

Long-leaf pine trees, if properly managed, may yield a turpentine product and have their timber value remain unimpaired. The Naval Stores industry of the United States in 1908 put out 36,500,000 gallons of turpentine and 4,000,000 barrels of rosin at a combined value of $32,000,000

blast furnaces and chemical plants to convert bark, limbs, edgings (Fig. 12) and even sawdust into some valuable product. If near a spool factory, birchlands may be profitable. Excelsior may be a paying product of mixed woodlands; the United States uses annually for excelsior 60,600,000 feet of timber (about 10,000 acres of forest). Each winter there is a large market for Christmas trees, especially near cities. Dealers estimate that New York City annually handles 125 carloads of Christmas trees, each carload containing 2000 trees. Large numbers of these come from the Adirondacks and from Canada. Gum picking may bring a considerable sum to dwellers near spruce forests (Fig. 44). The maple sugar and turpentine industries market "by-products" of a woodland without injuring its timber value, provided in the latter case that the trees are cut before injury comes to the chipped trees from insects or fungi (Figs. 45 and 46).

WORK OF FORESTATION

FORESTRY is of economic interest to landowners throughout the country, but planting trees in largest numbers must lie with the western farmer on prairie or newly-irrigated land. Each farm there, as well as in the East, should have its wood lot. In installing tree plantations in these regions, not only must fast-growing trees be chosen but also the young trees must be protected in nurseries until strong enough to endure exposure and until possessing top enough to shade the ground, for in summer the soil becomes dry. Greatest success has come in raising hardy catalpa trees (Fig. 47). A famous experiment with this tree was made on the Yaggy plantation in Reno County. The trees were grown from seeds and the seedlings were transplanted when one year old between rows of corn to the permanent site. One hundred and twenty acres were planted in 1890, eighty acres in 1891, two hundred and forty acres in 1892. Ten years' growth realized a net gain of $197.55 per acre, which amount will be greatly increased by a few years' delay in harvesting. Hardy catalpa is a species with known values in the present market, i. e. trees six years old produce posts valued at ten cents each; trees fifteen years old make ties worth fifty cents each, and two or more posts besides; trees twenty-five years old can be cut for telegraph poles which may realize fifty dollars each.

Tree planting is advisable as follows:

(1). In the forest where gaps made in thinning or in removing a crop

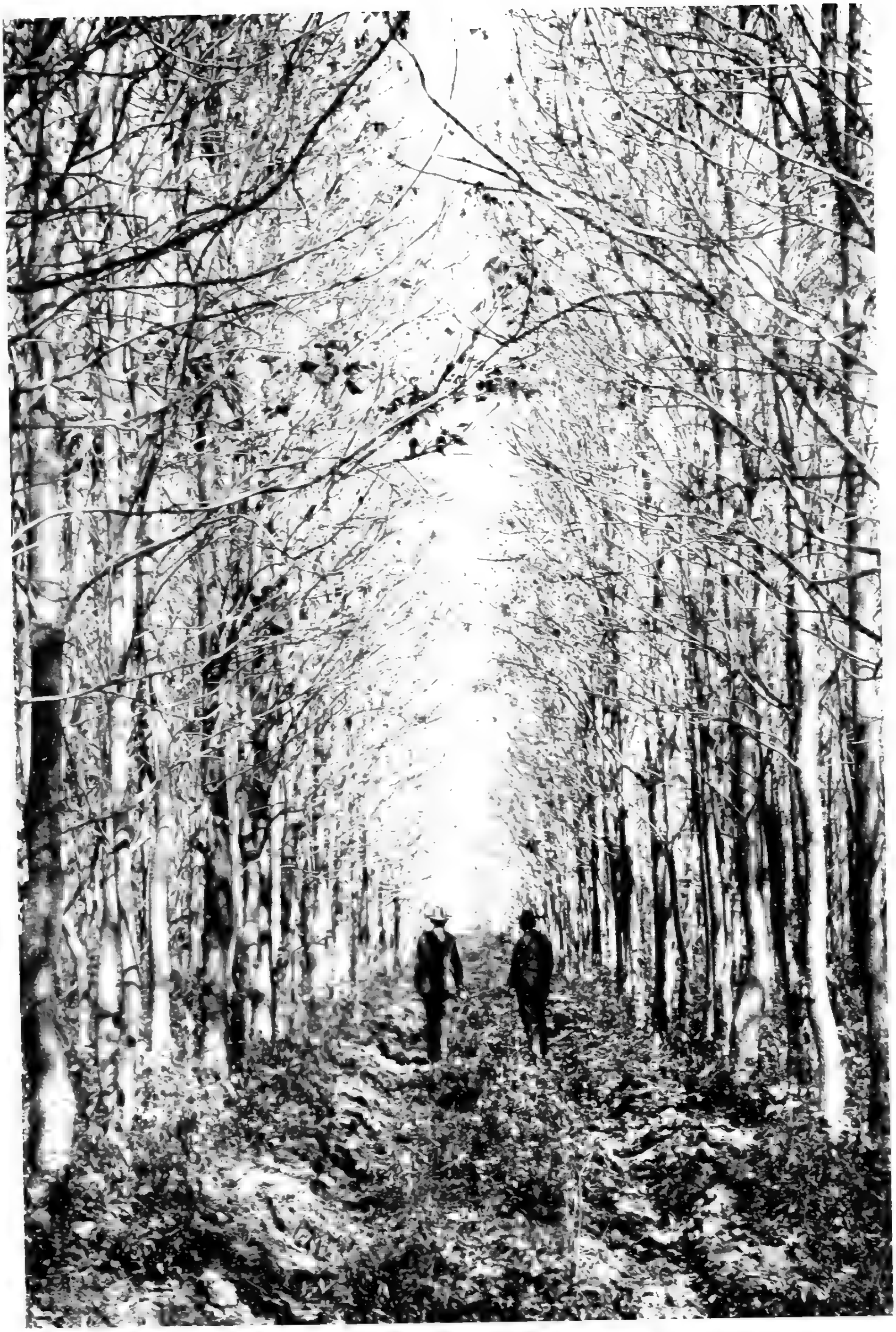


FIG. 47 PLANTED HARDY CATALPA, KANSAS

Catalpa attains size for posts in 8 to 10 years, for telegraph poles in 20 to 30 years. See p. 54

are so large that the crowns of the remaining trees will not meet and shade the ground within a short time.

(2). On rocky land with thin soil little valuable for agriculture.

(3). In wet places where no other crops will grow (Fig. 48).

(4). On hillsides too steep to plow (Fig. 4) especially if these slopes adjoin fertile fields and are subject to washing (Fig. 5). If a forest in such

FIG. 48. DISMAL SWAMP, SHOWING "CYPRESS KNEES"

The rich soil of swamp lands supports luxuriant growth. Giant cypress trees have been known to measure 40 feet in circumference.

A problem of the immediate future: to drain swamp lands north and south, plant forests, and incidentally better health conditions

FIG 49. SEED PLANTERS, ANGELES NATIONAL FOREST, CALIFORNIA
Trees should be planted on hillsides too steep to plow, in the East or in the West.

a situation is to serve a double purpose, namely, furnish a tree crop for market and protect agricultural land, it is best to plant nursery-grown stock to control the species and hasten the reforesting.

(5) Along sandy shores, or along mud banks of rivers and creeks. Such forestation is imperative when the watercourses run through fertile soil which washes away during fall and spring freshets.

In addition to a wood lot there should be shelter belts of trees to protect buildings, crops or stock feeding-grounds from prevailing winds. It is advised that not less than one-eighth of a farm consist of woodland. Along the exposed sides of a wood lot encourage the growth of a dense border of shrubs and low trees to protect the woodland from drying and to prevent windfalls. If a forest border is to be planted, choose a rapid-growing species, such as box elder, hardy catalpa or Carolina poplar, and one or more slow-growing species for later and permanent protection, such as any of the conifers.

No tree crop in the East is likely to prove more profitable than white pine, in the wood lot, on sandy shores, hilly fields or worn-out land. White pine reaches marketable size in thirty-five years, i. e. growing close (6 to 9 feet apart each way) and unpruned for box-boards. A tract of pine for high-grade timber should remain uncut for a somewhat longer period. Such a tract will increase its value greatly, even fifty per cent, if the trees

FIG. 50. EFFECTS OF EROSION, CATAWBA COUNTY, SOUTH CAROLINA

Trees should be planted on sandy slopes that lead down to fertile fields. Such trees will furnish a tree crop as well as protect the fields from erosion

FIG 51. KNOCKING SEEDS OUT OF PINE CONES

Cleveland National Forest, California

are kept thinned and pruned. Such a cared-for tract may yield 25,000 B. M. per acre, five times the average yield of Michigan white pine forests.

The following figures are interesting for owners of New England abandoned farms:

Average cost per acre of land	$4.00	
Average cost of raising and planting seedling white pines	4.84	
Average taxes at 2 per cent for 40 yrs.	3.20	
	$12.04	
Compound interest for 40 yrs. making total cost	$50.99	per acre.
Average yield per acre box-board timber, 40 cords, at $4 per cord	$160	
Net profit	$109.01	per acre.

GROWTH OF TREES FROM SEEDS

TREES in nature grow not only from seeds but also from stump sprouts and sometimes from cuttings (twigs broken from the trees during storms). Man's best method, with few exceptions (see p. 62) is to grow trees from seeds.

Obtaining the Seeds

Seeds may be purchased from nurserymen but the grade is not always reliable and the cost is high. If possible, collect the seeds for the immediate need. Collect thoroughly ripe seeds from well-grown roadside or field trees or from trees at the edge of the forest, remembering that as a rule the best and largest seeds produce the best trees. If seeds are obtained from a distance, the resulting trees will be hardier if the seeds come from a more northerly rather than from a more southerly section. Test the seeds by cutting open a few to see that the kernels are plump and moist. If desired make an absolute test as follows: plant some of the seeds in sphagnum or wet sand; cover the seeds their own depth and keep moist; the greater number of tree seeds germinate in from ten to thirty days.

Disposition of Tree Seeds for the Winter

Nature plants tree seeds soon after they ripen; the time of sprouting is another matter. Seeds that ripen in the spring are likely to sprout and make strong seedlings before winter; such are the elms and soft maples, poplars and willows. Of those that ripen in the fall, a few such as the white oak may grow before frost, but the larger number wait until spring. Among those that lie dormant one or more years are the linden, locust and red cedar.

Seeds should be removed from their cones, husks or pulpy coverings (Fig. 51) and then spread out to dry in the sun or in a warm room of the house. Dry only enough to prevent moulding; excessive drying destroys the vitality of the seeds. To insure for the winter the safe keeping of nuts and acorns and the smaller seeds, except those of conifers, arrange in a box in layers separated by layers of moist sand. Store this box in some cool cellar-like place or bury it in a shallow pit out of doors, heaping the soil above and further protecting from rain by boards. Seeds of pine, spruce and other conifers may be kept in boxes of dry sand, or in bags hung in a dry, cold place.

If a seed bed can be made in the fall, many seeds may be planted advantageously at that time. The loam of the ordinary garden bed serves well for broadleaf trees; conifers need a mixture of loam and one-third sand. The

seed bed should be spaded deeply and well fertilized with forest mould, phosphate of lime or well-rotted manure. Locate the seed bed on the north side of some building, fence or hedge so that it will be sheltered from too great sun. The seeds may be sown very thickly in drills 8 to 10 inches apart. Cover them about twice their own depth; seeds are often killed by deep planting. Cover the seed bed with a two-inch layer of chaff or of sphagnum or pine needles to keep the soil from drying. Before frost comes give the bed a thick protecting cover of hay or straw.

Spring Planting of Tree Seeds

If the seeds kept through the winter are to be planted in an out-of-door seed bed they should not be removed from their winter quarters until time for that out-of-door planting after the frost is out of the ground; but if they are to be started in flower pots or boxes in the house, they may be brought out and planted in February or March. They must be planted immediately on being disturbed. The surface of the earth in the flower pots or boxes should be kept moist by a layer of sphagnum or chaff, of crushed dead leaves or of pine needles.

Most tree seeds are slow in germination, beech, maple and oak requiring

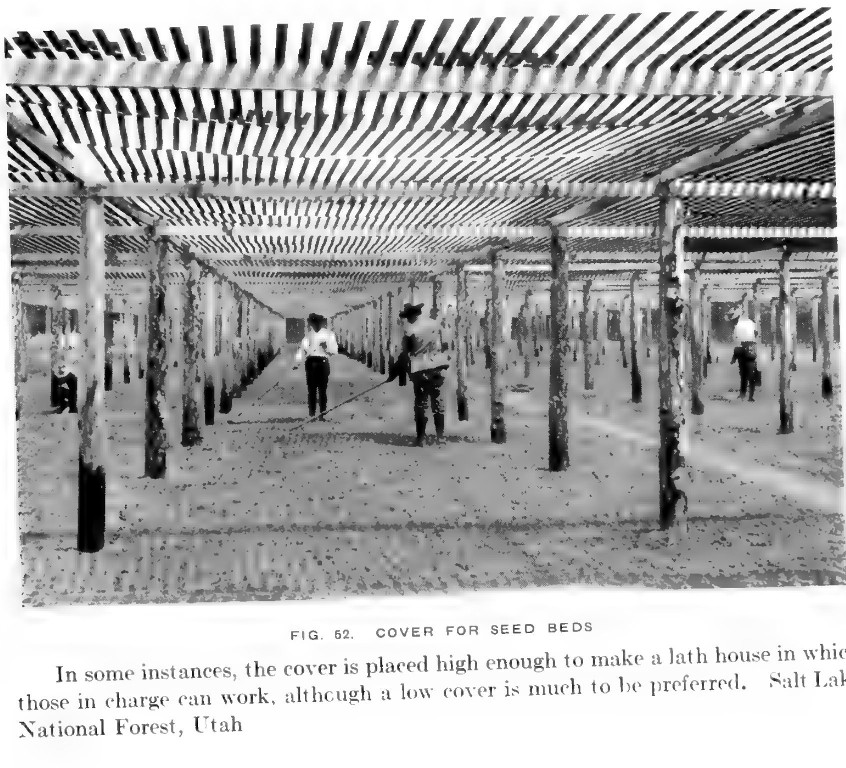


FIG. 52. COVER FOR SEED BEDS

In some instances, the cover is placed high enough to make a lath house in which those in charge can work, although a low cover is much to be preferred. Salt Lake National Forest, Utah

six weeks to appear above the ground, pine and spruce four weeks. Growth may be hastened by soaking the seeds twenty-four hours before planting. Seeds of linden and locust should have boiling water poured over them or should be soaked in hot water for three or four days.

How to Care for Seedling Trees

As a rule seedling trees grow very slowly their first year. Pines grow three inches or less, in fact, pines grow very slowly for the first five years and not rapidly until they are ten years old. Broadleaf seedlings grow faster than those of conifers; chestnut and a few others make the astonishing growth of fifteen to twenty-four inches their first year.

Seedlings grown in the house need the ordinary care given to house plants. If they are grown in the seed bed they must be kept partly shaded, and be protected from wind. It is suggested that a bed have a cover made of strips of lath, the width of a lath apart. This cover should be placed one foot or more above the bed, held on stakes driven into the ground at the corners of the bed (Fig. 52). A cover similar to this may be made of brush. Any cover should be movable so that it can be taken off on dark days. Conifers should be shaded for two or three years; broadleaf trees only during their first season.

Keep the soil of the seed bed loosened; also free from weeds. Thin the seedlings so that each will have light and air. For winter protection the row of seedlings should be banked with earth and the nursery bed covered with straw. For directions for transplanting see p. 64.

GROWTH OF TREES FROM CUTTINGS

WILLOWS and poplars may be grown from cuttings. Thus a quick method is provided for covering land to hold the soil along streams (cottonwood is recommended for irrigation ditches), and to prevent severe erosion from overflow.

The cuttings may be put into their permanent place at once or may be started in a nursery bed or in boxes. Considerable moisture is needed until the roots are formed. The usual cuttings are one foot in length and one-fourth to three-fourths of an inch in diameter. Plant with the buds pointing upward, and place three-fourths or more of the cutting underground. The soil must be closely packed above each cutting.

Good results are gained by making the cuttings in late fall and keeping them buried in sand in the cellar or in some out-of-door place till spring, then planting as described. This is like the natural method; that is, the winter winds may whip twigs from willow trees, these twigs may lie dor-

mant, only healing the broken place, and grow in spring, increasing the number of willows along river or swamp.

In the practical work of growing willows for basketry — a paying venture in the meadows and bottomlands of agricultural districts — cuttings are started in beds or boxes in the fall and transplanted in the spring. The farmer plows a long furrow, lays the cuttings in the furrow, then plows a second furrow to close the first; makes a third for cuttings, a fourth to close it, and so on, putting some 34,000 or more cuttings to the acre. (For details concerning willow growing and its financial returns see Bulletins 19 and 46, U. S. Forest Service; also Circular 148.)

GROWTH OF TREES FROM SPROUTS

BROADLEAF trees, in distinction from conifers, have the inherent tendency when cut down to sprout from the stump, that is, to form new buds in the cambium. As we should expect, this sprout growth is unusually rapid at first, fed by the perfected root system of the original tree; and trees possessing the sprouting power in large degree have great economic value. A forest of basswood, catalpa, chestnut, blue gum, black locust, soft maple, Russian mulberry, Osage orange or white willow

FIG. 53. PLANTATION OF BLACK LOCUST

This species is valuable since it thrives in plantations and has an extensive range. See p. 64

can be perpetuated for many succeeding crops of posts or poles, fuel, or small timber without renewal from seeds, but the sprouting power diminishes gradually with age.

To insure good sprout growth, the trees should be cut in winter or early spring and should be cut low. The stump must be as nearly level with the forest floor as possible so that it will be protected by a cover of leaves and snow and so that the sprouts may early form their own root systems. If the stump is a foot or more high, the cut surface should be oblique in order to shed the rain. All of the sprouts except three or four of the stronger ones should be removed at the close of the first season to give space and light for those remaining.

For hedges and windbreaks, Osage orange sprout trees are recommended. For production of fence posts in sprout forest, chestnut, hardy catalpa (Fig. 47), black locust (Fig 53) Russian mulberry and Osage orange are valuable. If the purpose of a wood lot is the production of posts, poles or ties, the sprout method is used even at the beginning; that is, at the close of the second year after the seedlings are in their permanent sites, they are cut back to the ground, then at the end of the next year all but one sprout is cut away; thus is gained a taller, straighter shaft than the seedling would have given. During the succeeding years these shafts are kept well pruned of low branches.

TREE AND SHRUB TRANSPLANTING

CHOOSE trees that are not too large and that are free from fun i and insects. The various maples and the American elm transplant easily and may be eight to ten feet high; but almost any forest tree can be safely transplanted if only three or four feet in height. Choose trees suitable to the given purpose as well as to the selected place, — lawn, school grounds, roadside, windbreak, or denuded forest. Have in mind, however, that any tree or set of trees may serve secondary purposes, i. e. the trees of a windbreak may eventually produce good timber or telegraph poles; trees valuable for the roadside may also produce nuts or valuable tree seeds, or may have flowers that yield large amounts of honey.

It will pay to transplant wild seedlings to a nursery bed, strengthen them there for one or more years, then transplant to a permanent site. They must be transplanted as carefully as the older trees and must be shaded at first, as are nursery-grown seedlings.

It is thought that the transplanting of certain trees, especially of oaks and conifers, is made more liable to failure by an interdependence that

exists between the trees' roots and minute fungi of the soil (Mycorrhiza). When a tree is transplanted, these fungi are largely left behind and are likely to be lacking in the new soil.

Time of Transplanting

Transplant on wet or cloudy days in spring, or in warm regions in fall, when the tree is without its leaves and before the buds have opened. As soon as the buds open, it is too late to transplant with best success, since the new leaves will very likely die and the loss may not be replaced quickly enough to save the tree.

In the case of evergreen trees, theoretically any season will serve for transplanting, since they never lose all of their leaves. Practically, however, the best time is spring, when the buds for the new year's growth have not opened and the soil is not frozen. Summer cannot be the best time, since evaporation from the leaves under the summer sun must be so rapid that the tree may be injured before the roots are properly at work (see below, for ball planting of evergreens).

Method of Transplanting

The secret of successful transplanting lies in removing the tree from the ground with roots as nearly unbroken as possible, and in *keeping these roots from drying.* Do not expose the roots to sunlight or wind even for a few seconds; cover them — and keep them covered till they are in the ground again — with wet sphagnum or wet cloths, or best of all put them at once into a pail or tub of thin mud. Small trees may be carried in a pail of mud from the woods to the planting site.

If desired, ball-planting may be practised, that is the roots may be removed in a mass or block of earth. Conifers are difficult to transplant, in that they never revive if there is any drying of the roots, therefore ball-planting is recommended for them. This is often accomplished in winter, in which case the transplanting is begun at the approach of freezing weather, the hole for the tree is dug in the permanent site and the removal of the tree started. The digging about the tree is done a little at a time to allow deeper freezing of the soil about the roots; the tree is not removed to the new site until all of the soil is frozen even at the bottom of the block.

The hole for a tree should be dug wide enough to take the roots spread out in their natural position, and deep enough to let the tree settle into the soil to a position similar to that it had before transplanting. The soil to be put back into the hole must be made free from lumps and stones, so fine that it can be sifted about the roots. There must remain no air spaces, where rootlets may die because they cannot reach food. If the soil

is not good growing soil, it should be enriched by the admixture of well-rotted manure.

Hold the tree perpendicularly in position and sift fine soil over and around the roots till they are covered, slightly lifting and lowering the tree in its place to allow the particles of soil to settle close under and about the rootlets. After this, fill the hole with shovelfuls of soil, treading it down firmly as it is put in. Fill to a little higher than the surrounding level to allow for settling. Use no water during the transplanting unless the ground is very dry, in which case, put water on by sprinkling or spraying after the soil is well packed about the roots.

Trim the top of the tree so that it will not greatly exceed the extent of the root system, which probably was reduced in the transplanting. This cutting away of branches is especially necessary if the transplanting is done late in spring when the tree is in leaf, for the evaporating surface must be reduced. It is best for both the latter reason and for relation to the root system that evergreens be cut back whenever transplanted.

Almost any young shrub one to three feet tall, depending on the kind, can be successfully transplanted if care is used to keep the roots moist. Nothing could be more satisfactory for massed effects at the sides of the home lawn or for the school grounds, than the wild shrubs from the roadside or the woods border. Such shrubs are laurel, witchhazel, elderberry, spice-bush, sumach, flowering dogwood, red osier, maple-leaved viburnum, thorn apple, barberry and many others.

In planting a mass of shrubs follow directions for tree transplanting except that the whole space must be dug up so as to set the shrubs two to three feet apart. Do not leave sod between the shrubs or allow grass to grow there later.

Transplanting Stock from the Nursery

A tree nursery needs the same situation, soil and preparation as a seed bed (see p. 60). If the soil is dry, wet thoroughly the day before the transplanting. For hand cultivation, plant in parallel rows 2 feet apart; for horse cultivation, the rows may be $3\frac{1}{2}$ to 4 feet apart. Dig the trenches such depth as to allow transplanted seedlings to stand 1 to 2 inches deeper than they grew. Set conifer seedlings 4 inches apart in the rows, broadleaf seedlings 6 inches apart.

The important item here, as in all transplanting, is to avoid exposure of the roots to air for even a few seconds. As soon as the seedlings are out of the soil they should have moist earth, wet cloths or chaff thrown over them, or should be put into a pail or tub of thin mud. Leave plants in the nursery until 12 to 18 inches high.

Transplanting seedlings one or more times, from seed bed to nursery, from nursery to permanent site, strengthens the root systems by making

them more compact, and the resulting young trees are more vigorous than those left undisturbed. The long tap roots of oaks and walnuts and of catalpa should be cut off at the first transplanting. Older plants in the nursery should have root pruning some time before the last transplanting, that is, a sharp spade should be thrust into the soil around and under the trees.

PLANTING GUIDE

Compiled from the reports of the United States Forest Service

REFER to the Jesup Collection of woods for facts concerning the character of the wood and the economic value of each species with its associate trees; also for maps showing natural range. It was the original aim of Mr. Jesup that architects, cabinet makers and others interested in wood, as well as those interested in growing trees as a commercial venture, might have a ready place of reference for getting acquainted with not only the well-known species of American trees but also the many others little known and appreciated in the lumber market.

A forester can tell the rate of growth of various trees and therefore can estimate the time that it will take a given species to reach merchantable size and the average product that it will yield per acre. He can foretell, as a result, whether a particular woodland will or will not give satisfactory returns under the existing conditions of taxation and with the possibilities of fire. The United States Forest Service advises free of charge any applicant with a problem for economic tree planting. Foresters study the conditions of the locality and give particulars concerning species to be planted, how to obtain the young trees and how to plant them and care for them. If the application comes from some region not previously studied by the Forest Service, it may send agents to examine the locality and prepare planting plans. In certain cases, this direct examination may be made free of cost even for large commercial undertakings, provided the work is of considerable experimental and educational value. (See Circular 22, United States Forest Service.)

The Australian eucalyptus is proving a valuable discovery for America. Forestry experts are studying the problem of its successful culture both in the Southwest and in Florida. Eucalyptus has unusual rapidity of development coupled with an all-round usefulness of wood, and under the right climatic conditions is likely to give commercial crops in a much shorter period than our native trees. More than 23,000 acres in California have been turned over to eucalyptus growing during 1909 and 1910.

Many of the trees in the following list are those about which the United States Forest Service has gained definite planting data through actual experience and which have been proved to give best results under artificial conditions.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Green Ash (*Fraxinus lanceolata*) Case F, 10	Wood hard, strong, coarse-grained, somewhat inferior to white ash but often substituted for it. Used for agricultural implements, furniture and vehicles, posts and fuel. One of the most useful trees for windbreak or ornament.	Recommended for economic planting in the eastern half of the United States, also on the northern prairies and the semiarid plains east of the Rocky Mts., and on all irrigated western lands. Will thrive under adverse conditions, growing on dry sandy loam or stiff clay upland.	Nursery culture necessary. Transplant 1 year old seedlings (6–10 in. high) to permanent site. (Nurserymen's price $2 to $3, per thousand for seedlings). Cultivate till ground shaded. Pruning will increase value. Growth relatively slow. Post size attained in about 15 years. Height at maturity 60 ft., diameter 24 in.	Endures shade only moderately. Recommended for pure stands, spacing 4 by 4 ft.; or combined with box elder, hackberry, white elm, Scotch pine or red cedar (spacing 6 by 6 ft.) If planted pure, may be given an understory of wild plum, chokecherry or other shade-enduring low trees to keep out grass and weeds.	The more valuable white ash is to be preferred in moist regions. On abandoned timber claims in arid parts of Nebraska green ash has survived where nearly all other species failed.
White Ash (*Fraxinus americana*) Case F, 11	Wood of great value; tough, elastic, fairly durable in contact with the soil, takes good polish and seasons without injury. Used as first-rank timber for furniture, interior finish, cars and vehicles, tools and agricultural implements. Good for fence posts. Favorite for ornamental planting.	Newfoundland to northern Florida west to Ontario and Texas. Recommended especially for the Ohio Valley, the region of the Great Lakes, and irrigated lands in arid western districts. Gains best growth in rich moist soil; in dry situations should give place to the more hardy green ash.	Transplant seedlings from nursery at end of first year (6–12 in. high). Young seedlings endure dense shade. Till the plantation for three years until the ground shaded. Growth relatively rapid under good conditions; post timber obtained in 10–15 years. Sometimes reaches height at maturity of 100 ft., diameter of 3–4 ft. Renew stand from stump sprouts which give more valuable wood than the original seed forest.	Only moderately shade-enduring. May be planted pure though it thrives when mixed with catalpa, Scotch pine, European larch, black walnut, black cherry or hackberry.	Must be watched for fungous parasites and insect enemies. Autumn foliage purplish brown.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Basswood (*Tilia americana*) CASE A, 5	Wood known as "whitewood," soft, straight-grained, and easily worked; not durable in contact with the soil. Used for general construction lumber, woodenware, paper pulp, trunks, carriage bodies. Desirable for ornament and in shelter belts.	Recommended for moist and well-drained soils in the northeastern States to the Ohio Valley inclusive.	Transplant 1-year-old nursery-grown seedlings. Space 5 ft. each way. Growth rapid during first years, about the same as in Norway maple and red oak. Little cultivation needed. At maturity height 80 ft. Renew plantation by stump sprouts.	Moderately shade-enduring. Pure stand recommended, also mixed stands with white or red oak, white elm, maple, hickories or with white or red pine.	European species less valuable and more liable to insect injury. Flowers valuable to bee-keepers
Box Elder (*Acer negundo*) CASE C, 12	Wood soft and weak, light, close-grained. Used for woodenware, firewood, paper pulp, and an inferior grade of interior finishing and furniture.	Recommended for the treeless West from North Dakota to Texas. Will thrive in many soils but prefers deep, moist loam.	Transplant nursery-grown seedlings to permanent site when they are 1 year old (10–14 in. high). Space 5 ft. by 5 ft. or 4 by 6. Growth moderately rapid. Annual height increase 1–10 ft., diameter increase 1 in. Average height at maturity 40–60 ft., diameter 1–2 ft. Tree short-lived.	Shade-enduring, so may form a lower story combined with white elm honey locust, black locust, green ash, black walnut or European larch.	Good for windbreaks and as street trees because of hardiness but inferior to many others in every region. Does not grow straight enough for posts and produces less firewood per acre than either cottonwood or willow.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Hardy Catalpa (*Catalpa speciosa*) CASE F, 26	Wood most valuable; light, elastic, very durable in contact with soil. Fence posts may remain sound thirty to forty years. Used in cabinet work. Has high value for fuel, posts, small poles and railway ties.	Recommended for economic planting on fertile lands of the Middle West, south of the 41st parallel. It grows well in the southern parts of Ohio, Illinois and Indiana; in Nebraska south of the Platte River; in eastern Kansas; and on irrigated lands in New Mexico, Colorado and Utah. Will not grow well on poor sandy or stiff clay soils.	1 lb. seed yields 12,000 seedlings. Transplant from nursery when they are 1 yr. old (12–14 in. high). Space 4 ft. each way. Growth most rapid. Annual height increase $2\frac{1}{2}$ ft., diam. increase $\frac{1}{2}$ in. Post size may be reached in 8–10 yrs. Telegraph poles in 20–30 yrs. If entire seed forest cut for posts after 15–20 yrs., it will renew rapidly from stump sprouts.	Not shade-enduring, therefore pure forest recommended, or associates like Russian mulberry or Osage orange which will endure shade and so act as a "filler" to force pruning and straight growth of the catalpa.	In 1888 a ten-acre grove of hardy catalpa was planted at Pioneer, Iowa. In 1908 the grove consisted of trees 25–32 ft. tall, 4–10 in. diameter, worth $2,825.70 in posts. Catalpa plantations should be protected by a windbreak of hardier trees. The common catalpa is much less hardy, and less erect in habit.
Red Cedar (*Juniperus virginiana*) CASE N	Wood light, soft, of very fine and even grain, and very durable. Used for posts and poles, sills, railway ties, somewhat in naval construction; but chiefly for lead pencils, cigar boxes and chests. The pencil industry uses 125,000 trees annually.	Thrives as far north as Nova Scotia and Dakota, but reaches best development south of Ohio Valley. Recommended for economic planting especially in Plains States west of Mississippi.	Buy nursery-grown seedlings, or transplant wild seedlings to nursery till 10–12 in. high. Space 4 ft. by 6 ft. Height at maturity 50–80 ft., diam. 2–3 ft. Timber produced in 70–120 yrs.	Plant pure, or with Osage orange or honey locust for windbreaks.	Fragrance of wood utilized as insecticide. The western red cedar (*J. scopulorum*) and the southern red cedar (*J. barbadensis*) give wood of similar grade.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Black Cherry (*Prunus serotina*) CASE D, 7-8	Wood light, hard and strong. It works easily and takes a beautiful polish. It has high value in cabinetmaking and interior decorating.	Reaches best development on rich, moist, well-drained land. Recommended for the moist slopes of the Appalachians, and west of Indiana through eastern parts of South Dakota, Nebraska and Kansas.	Use nursery stock from seed. Transplant 1 yr. old seedlings, spacing 4 ft. by 6 ft. Relatively rapid-growing and short-lived. Serves well as nurse tree for slower-growing trees. In 10 yrs. attains height of 23 ft., diam. of 6 in. Mature height 40–80 ft., diam. 3 or more ft.	Combine with box elder, green ash, white ash, silver maple or black walnut.	The wood of the cultivated cherry is not used in the United States. Black cherry has various local names, such as rum cherry, whiskey cherry, choke cherry and wild cherry.
Chestnut (*Castanea dentata*) CASE K	Wood light, moderately strong, coarse-grained and elastic; works easily and is very durable. Used in cooperage; for posts, poles, ties and mine timbers; valuable in cabinet work.	Will thrive in dry sandy or gravelly soils. Recommended for planting throughout the East particularly in New England, New York, Pennsylvania, Maryland and the Ohio Valley. Will grow well also in the West on irrigated lands.	Plant 1 yr. old nursery grown seedlings (10–15 in. high), spacing 5 to 6 ft. each way. Grows rapidly; annual height increase 15–20 in. till 30 years old. Renew forest from stump sprouts every 25–35 years. Sprout trees grow more rapidly than seed trees and produce timber in many respects better.	Pure stands recommended renewed by sprout growth. If mixed, plant with white pine, European larch or with maples, ashes or oaks.	Chestnut poles, ties and timber are in great demand. **See note p. 37 on chestnut blight.**

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Coffeetree (*Gymnocladus dioicus*) CASE C, 17	Wood heavy, hard and stiff, coarse in texture, and durable. It works well and takes a good polish. Heartwood reddish. But little known commercially. Valuable for general construction work, for posts, for cabinetwork.	Recommended for commercial planting within its range, New York to west of the Mississippi, south to Tennessee. Also on the semiarid plains of Kansas, Nebraska, Oklahoma, Texas, Colorado and New Mexico. Reaches best growth in deep rich moist soil, but thrives in drier situations, enduring cold winters or hot winds.	Plant nursery seedlings 1–2 yrs. old. Rapid-growing under good conditions; annual height increase 1–2 ft.	Plant in mixture only, with white elm, red elm, hackberry, oaks or ashes. If given a few years start, may be combined with hardy catalpa, Russian mulberry, or black locust.	Valuable for general ornamental planting also.
Cottonwood (*Populus deltoides*) CASE L	Wood light and soft, not durable. Tendency to warp may be overcome by proper methods of piling. Used for fuel, paper pulp, box-boards, unexposed parts of furniture, interior woodwork. Produces a greater amount of fuel for a given period of growth than other trees.	Recommended for economic planting in watered regions of the Middle West. Especially recommended for the Ohio Valley. Is valuable on the northern prairies and the semiarid plains of the Middle West.	Start plantation from nursery-grown seedlings or from cuttings (latter cheaper). Rapid-growing; annual height increase 3–5 ft. for first 10–15 yrs.	Recommended for pure stands, and in mixture with shade-enduring hardwoods, or in moist situations with willow.	Valuable on uplands for windbreaks and along canals and streams to protect the land from overflow.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Slippery Elm (*Ulmus fulva*) CASE G, 3	Wood heavy, elastic, strong, moderately durable, works well. Used for furniture, for ribs of canoes and skiffs, for staves, hoops in slack cooperage, sleigh runners; also for fencing and fuel.	From the St. Lawrence to Florida westward to North Dakota and Kansas. Develops best in rich moist soils of valleys, but hardy in dry sites also.	Transplant 1 yr. old seedlings from nursery, spacing 4 ft. by 6 ft. Rapid-growing; 1 year seedlings 10–18 in. high.	Pure stands recommended. Good mixtures can be made with less shade-enduring hardwoods (white ash, green ash, hardy catalpa, locust or black cherry), or with the slow-growing black walnut, Scotch Pine and red cedar, if the elm is planted after the others have 5–6 yrs. start.	A more valuable tree than white elm. Because of rapid growth serves well as nurse tree for slower-growing species.
White Elm (*Ulmus americana*) CASE G, 4	Wood strong, tough and coarse-grained, not durable, difficult to work. Heartwood light brown. Used in slack cooperage, in shipbuilding, for flooring, wheels, agricultural implements.	In deep, fertile, well-drained soil, but thrives also under adverse conditions. Recommended especially for the Ohio Valley, for the semiarid plains of the Middle West and for the northern prairies.	Fairly rapid-growing and long-lived. Reaches height of 5–10 in. first year. Transplant from nursery when seedlings 1–3 yrs. old, spacing 6 ft. or less each way. Size at maturity, height 90–100 ft., diameter 3–7 ft.	Recommended for pure stands also in mixture with the more shade-enduring maples, ashes, and red oak or with black cherry, black walnut, yellow poplar and basswood.	Valuable in shelter belts and for ornamental planting. Known also as American elm and water elm. The cork elm, (*U. racemosa*) of Ontario and Michigan produces wood much stronger and heavier, used in bridge timbers and heavy agricultural implements.
Hackberry (*Celtis occidentalis*) CASE G, 2	Wood elastic, of medium weight, hardness, and strength. Used for cheap furniture. May be used as a substitute for elm and white ash; almost equals hickory for fuel.	Recommended for plains and prairies from Canada to Texas. Will thrive in sterile soil where almost any other tree would die. One of the best trees for the semiarid plains next the Rocky Mts.	Seedlings grow 6–12 in. 1st year. Transplant two year old seedlings from nursery, spacing 4 ft. by 6 ft. Mature growth 80 ft. high, 2 ft. thick. Tree lives 150–200 years.	Recommended for pure or mixed stands. Shade-enduring so can be made a lower story with cottonwood, walnut and ash, black locust, honey locust, or Osage orange.	Rivals white elm for shade tree in the Middle West. Good in mixture for windbreaks.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Shagbark Hickory (*Hicoria ovata*) CASE G, 8	Wood heavy, hard, very strong, tough, flexible, but not durable. Used for vehicles, agricultural implements, axe and tool handles; most valuable fuel; sprouts serve for barrel hoops and in basket making.	Recommended for good soil along the Ohio and tributaries and on fertile hillsides of the Appalachians. Does best in deep, rich, moist soil; will not thrive in hard clay or in sand.	Fairly slow-growing, comparing with white oak. Plant seeds in permanent site because of difficulty of transplanting seedlings (long tap roots). Space 6 ft. by 6 ft. First year's growth 6–9 in. Mature growth, height 120 ft., diameter 4 ft. Renew forest from stump sprouts.	Not shade-enduring. Recommended for pure stands or mixed with hemlock or maple, a lower story planted after the hickory is well started.	Wood in great demand bringing high prices. If trees are grown for nuts, space 20 ft. by 20 ft. Autumn foliage bright lemon yellow.
European Larch (*Larix europæa*) CASE M	Wood heavy, hard, strong, and flexible; very durable in contact with the soil. Largely used in shipbuilding. Very valuable for posts, poles and railway ties.	Recommended for commercial planting in Northeastern, Central and Lake States, to South Dakota. In Iowa, Arkansas and Nebraska it is one of the most promising of trees. Requires deep, well-drained, moderately fertile soil.	Transplant 2 yr. old seedlings from nursery, spacing 4 ft. by 6 ft. Most rapid-growing conifer in Northeastern States. Posts (3–5 in. diam.) grown in 9–16 years. Height at maturity 80–100 ft., diam. 2–3 ft.	Demands more light than other conifers. Do not plant pure. Mix with chestnut, white or green ash, white or slippery elm, Scotch pine, red pine, white pine, Norway spruce or red cedar. A mixture of three or four of these recommended.	Heartwood usually yellowish white, but when tree is grown in cold elevated situation, heartwood becomes reddish brown and harder.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Black Locust (*Robinia pseudacacia*) CASE C	Very tough, elastic and durable. Used for ribs of vessels, tree nails, insular shanks, and in vehicle construction. Equal to bur and white oak for fuel. Locust posts last 15–25 years untreated.	Recommended for any soil, except a wet heavy one, from the Atlantic to the Rocky Mts., south of the 38th parallel. Especially valuable for semiarid plains of Kansas, Nebraska, Oklahoma, Texas, Colorado and New Mexico, as well as for irrigated lands in Utah, Idaho, Oregon and Washington.	Transplant 1 year old seedlings (1–3 ft. high), spacing 4 ft. by 6 ft. (or 3 ft. by 8 ft. in Middle West). Short-lived but rapid-growing. Annual height growth 2–4 ft., diam. $\frac{1}{4}$–$\frac{1}{2}$ in. for the first 25–30 years. Height at maturity (50 yrs.) 80 ft., diam. 3 ft.	Requires much light. Plant pure, or increase the protective character of the stand by adding Russian mulberry, Osage orange or green ash.	Has been grown with success in California. Autumn foliage pure yellow.
Honey Locust (*Gleditsia triacanthos*) CASE C, 18	Wood heavy, hard and strong, coarse-grained; fairly durable. Used for fuel, fence posts, and poles. Most valuable for hedges and windbreaks and for general planting in treeless regions.	Recommended for deep, moderately good soils in Iowa, Nebraska, Missouri, Kansas, Oklahoma, Texas, Colorado and Wyoming. One of the hardiest trees for upland planting in semiarid regions of the Middle West.	Transplant 1–2 yr. old seedlings. Very rapid-growing. Grows 1–2 ft. high first year. Annual height growth, 1–2 ft., diam. $\frac{1}{3}$–$\frac{1}{2}$ in. Posts (3–5 in. diam.) grown in 8–14 years; at maturity height 75–100 ft., diam. 2–3 ft.	Will not endure shade. Give an understory of white elm, or mix with Osage orange, Russian mulberry and black locust.	Recommended as street tree. Equaled in drought resisting power only by Russian mulberry and Osage orange in the Middle West. Late in putting forth leaves. Autumn foliage pure yellow.
Silver Maple (*Acer saccharinum*) CASE C, 12	Wood light, not strong or durable. Works easily. Used for flooring, seats and cushion frame in cheap vehicles, flooring, furniture and excelsior. Plantations worth most for fuel.	Will grow anywhere in its natural range through the eastern half of the United States where there are deep soils in moist lowlands and river bottoms.	Short-lived and grows rapidly. Diameter increase $\frac{1}{2}$–1 in. annually. Height at maturity 115 ft., diam. 3–5 ft. Transplant 1 yr. old seedlings which can be procured from nurserymen at very low rate. Renew stand by sprout method.	Somewhat shade-enduring. Plant in pure stand or mix with some ground shading species, such as black walnut, catalpa, white ash, black cherry or black birch.	Good for shelter belts and for park and street trees though there are better trees in every locality. Less hardy than cottonwood or box elder. Autumn foliage yellow.

Names and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Sugar Maple (*Acer saccharum*) CASE C, 10	Wood heavy, strong, hard, and dense; not durable, takes a fine polish. Used in cooperage, for implements and vehicles, for interior finish and furniture, for woodenware, spindles and novelties, for musical instruments. Has high value for fuel, charcoal and wood alcohol.	Anywhere within its natural range, the eastern half of the United States. Needs moderately rich well-drained soils. Especially recommended for the Ohio Valley.	Long-lived and relatively slow in growth. Seedlings grow 6-12 in. first year. Transplant 2 yr. old seedlings from nursery. Annual height growth 1 ft. till tree 30-40 years old. At maturity height 120 ft., diam. 3 ft.	Shade-enduring, therefore forms a good understory in plantations of rapid-growing trees. Plant pure or mix with white pine, red pine, white oak, red oak, shagbark hickory, chestnut, basswood or yellow poplar.	Its sugar value in economic planting is greater than its timber value. For sugar production, a pure stand, widely spaced is the rule. Autumn foliage red yellow and green.
Russian Mulberry (*Morus alba tatarica*) CASE F, 20	Wood heavy, elastic coarse-grained, moderately strong, durable. Has high value for posts and fuel.	Recommended for economic planting in rich loam, sandy or clay soils in southern Nebraska, southern Iowa, Kansas, and Oklahoma. Especially good results obtained in the Ohio Valley. Valuable for windbreaks; recommended for silk culture.	Plant nursery-grown seedlings, spacing 4 ft. by 4 ft. Growth fairly rapid, attains height of 20 ft., diameter of 8 in. in 10 yrs. Fence posts produced in 9-15 years. Height at maturity 30-40 ft., diam. 1 ft. Renew stand by sprout method.	Plant pure, close and keep pruned for posts and fuel. Shade-enduring, therefore good for underplanting with black locust, honey locust, black walnut and green ash.	Will endure almost any amount of drought and neglect. Cannot endure cold winters. This tree is a hardy variety of the Asiatic white mulberry introduced into the United States in 1875.
Bur Oak (*Quercus macrocarpa*) CASE J	Wood heavy, hard, strong and durable; not distinguished from white oak in the markets. Used for posts, railway ties, and the purposes served by white oak.	On good soils anywhere east of the 98th meridian and in deep rich river bottom soils farther west. Recommended only for rich, moist, well-drained soils.	Slow in growth, like the white oak. Not easy to transplant because of long tap root, therefore, plant acorns in the permanent site; spacing 4 ft. each way. Greatest height at maturity 170 ft., diam. 7 ft. Renew stand by stump sprouts.	Not shade-enduring. Recommended for pure stands or in mixture with still slower-growing species which will force the oaks to taller growth.	One of the most valuable of the hardwoods. Highly desirable for ornamental planting.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Red Oak (*Quercus rubra*) Case J	Wood heavy, hard and strong, coarse-grained, moderately durable; not so strong or so durable as white oak, but more easily worked. Used for cabinetwork and interior finish. Not distinguished from white oak in the markets.	Recommended for economic planting on well-drained soils of medium quality or exhausted by cultivation, anywhere in the Northern and Central States.	Grows more rapidly than any other oak. Transplant 1 yr. old seedlings from nursery or plant acorns in permanent site. Height at maturity 150 ft., diam. 5 ft. Renew stand from stump sprouts.	Cannot endure shade. Plant pure or with slower-growing trees such as other oaks, or sugar maple, white elm or white pine. If planted in mixture with chestnut or hickory give it a start of 2-3 years.	By treatment becomes more valuable than white oak for cross ties. Red oak and scarlet oak (*Quercus coccinea* Moench) are highly recommended for use as street trees. Autumn foliage red.
White Oak (*Quercus alba*) Case J	Wood strong, heavy, hard, tough, close-grained, very durable. Used in ship building, heavy construction work, tight cooperage, vehicles, farm implements, ties, posts and piling, as well as for interior finish and cabinet-work.	Recommended for artificial planting in the eastern half of the United States; especially successful on the lower slopes of the Alleghanies and in the Valley of the Ohio. Can stand drought and cold but thrives best on rich, moist, well-drained loam in protected places.	Slow-growing, diameter increase in ten years in the forest 1 in., in plantations something greater. Height at maturity 60–100 ft., diam. 2-4 ft. (grown under average conditions). Transplant 1 yr. old seedlings from nursery, or plant acorns in shallow furrows or holes in permanent site. Renew by sprout method for ties or posts.	Will not endure shade and does well planted pure. May be mixed with red oak, shagbark hickory, mockernut hickory, chestnut, black walnut, yellow poplar, white elm, white ash or white pine.	Wood of great economic value, and has been so generally used that the supply is nearly exhausted. Valuable street tree. Autumn foliage red and russet brown.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Osage Orange (*Toxylon pomiferum*) Case F, 20	Wood heavy, tough, hard and strong. Used for railway ties, machinery, wagon felloes, insular pins, tool handles. Most valuable for hedges and windbreaks.	Recommended for economic planting in the middle western states from central Illinois southward and westward to eastern Colorado and New Mexico. Will stand aridity, therefore especially valuable for planting on the semiarid plains east of the Rocky Mts.	Grow seedlings or purchase from nurserymen ($1 to $3 per thousand). Equals Russian mulberry in rate of growth but falls behind black locust. Posts (3–5 in. diam.) produced in 7–11 years. Height at maturity 60–70 ft., diam. 2 ft. Renew by stump sprouts for posts or fuel.	Endures shade, therefore can be made to occupy a lower story in a mixed stand with black walnut, black locust, honey locust or green ash.	Surpassed in hardiness only by red cedar. A 10-acre tract was planted at Farlington, Kansas, in 1878. In 1900 it yielded a total value of $524.04 per acre. The land could scarcely have been used to bring better returns.
Jack Pine (*Pinus divaricata*) Case O	Wood light, soft and coarse-grained, fairly strong and fairly durable. Good for coarse lumber and posts and for ties when treated.	Recommended for north Central States where soil is sterile or sandy but supplied with moisture not far below the surface. Very hardy, growing with success where few other trees will grow.	Short-lived and one of the most rapid-growing of the pines. Transplant seedlings 2–3 yrs. old, spacing 4 ft. by 4 ft. Height at maturity 60–90 ft., diam. 2 ft.	Not shade-enduring. Plant pure or mix with green ash or hackberry which will not overtop it.	Somewhat inferior to red pine and to western yellow pine. Valuable for windbreaks.
Red or Norway Pine (*Pinus resinosa*) Case O	Wood heavier, harder and stronger than white pine, only moderately durable. Used for house lumber and, when treated, for posts, ties and mine props.	Recommended for economic planting in northeastern part of the United States in situations suitable for white pine.	Transplant nursery-grown seedlings when 3 yrs. old, spacing 4 to 6 ft. apart each way. Growth fairly rapid. Attains height of 35 ft., diam. of 6 in. in 30 years. Height at maturity 90 ft., diam. 2–3 ft.	Light-demanding. Plant in pure forest or mixed with trees of slower growth, such as chestnut, red oak, sugar maple or European larch.	If planted close, clears well of lower branches without pruning. Compares with western yellow pine in characteristics of the wood.

Name and Location in Jesup Collection	Economic Value	Where to plant	Growth	Associate Trees	Remarks
Scotch Pine (*Pinus sylvestris*) CASE P	Wood strong, elastic, close-grained, works easily; not durable in contact with the soil. Used as fuel, for staves and heading in cooperage, box-boards and general construction work; when treated, suitable for railroad ties and mine timbers.	Scotch pine thrives in a dry atmosphere which fact recommends it for wide planting as a substitute for white pine. Recommended for northeastern United States and especially for the prairie states such as Nebraska, Iowa and Kansas.	Transplant from the nursery when seedlings 3 yrs. old (9–12 in. high), spacing 4 or 5 ft. each way. Growth fairly rapid. In Europe attains at maturity height of 120 ft., diam. of 3–5 ft. Yields mine timbers in 30–40 yrs.	Light-demanding. Plant pure, or mixed with trees that grow more slowly or demand less light. Combinations with European larch, Norway spruce, white pine and red pine are recommended.	More intolerant of shade than any of our native trees except aspen, birch and the larches.
Western Yellow Pine (*Pinus ponderosa*) CASE P	Wood light, strong and dense but only moderately durable. Used more extensively than any other wood of the Rocky Mt. region for lumber, railway ties, mine timbers and fuel.	Especially recommended for planting in the sandhill regions of western Nebraska and Kansas, and in the watersheds of the Rocky Mts. and the Pacific Coast below 6000 ft. elevation.	Transplant nursery-grown seedlings. They should be 2–3 yrs. old, having previously had some root pruning and transplanting. Growth fairly rapid. Height at maturity 200 ft., diam. 6 ft.	Recommended for pure stands.	A hardy pine, enduring many kinds of soil and climate. The wood is the most valuable of that produced in the Rocky Mt. region.
White Pine (*Pinus strobus*) CASE P	Wood soft, light, straight-grained and easily worked. Used in naval and general construction work but now largely superseded by other woods because of its scarcity. Second growth white pine is used for box-boards, pail staves, matches and woodenware.	Recommended for economic planting on non-agricultural lands of New England, Pennsylvania, New York, the Lake States and the higher slopes of the Appalachians. Will thrive on dry sands or on medium heavy clay and loam soils.	Transplant 3 yr. old seedlings from nursery (6–9 in. high). Annual diam. increase $\frac{1}{4}$–$\frac{1}{3}$ in. Height at maturity 150–175 ft., diam. 3–5 ft. Thin stand when 20–30 yrs. old. Box boards produced in 30–40 yrs.; saw timber in 60–70 yrs.	Plant pure or mixed with trees of slower growth, or less light-demanding, such as chestnut, European larch, Norway spruce, red oak and sugar maple.	Especially recommended for reforesting the abandoned farm lands of New England. (See p. 59) White pine trees may live 250 years.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Yellow Poplar or Tulip Tree (*Liriodendron tulipifera*) Case A, 3	Wood light, soft, tough and of fine texture, but not strong; fairly durable. Used for boxes, toys and woodenware, wagon boxes and carriage bodies, slack staves and heading, siding, paneling, interior finish, backing for veneer. Valuable for wood pulp.	Recommended for planting in Tennessee, Kentucky and western Carolinas, also in the Valley of Ohio and its tributaries. Yellow poplar attains its best growth in deep, fertile, well-drained soil having a constant supply of moisture.	Nursery-grown seedlings give best results, transplanted to permanent site when 1 yr. old. Young trees endure shade. Rapid-growing and long-lived (300 yrs). 1-2 ft. is the annual growth for first 40 50 yrs.	Will not endure shade and not strong enough to be planted pure. Combine with slow-growing trees (or give the poplar a few years start), with white pine or Norway Spruce or with a shade-enduring hardwood.	Often used where formerly white pine served. "White" poplar of the lumber market is the wood of trees grown on dry gravelly soil. Highly recommended for shade and ornament. Autumn foliage pure yellow.
Norway Spruce (*Picea excelsa*) Case N	Wood light, soft and non-resinous; works well and is fairly durable. Used for construction timber, fuel and wood pulp.	Will thrive in a shallow soil and dry climate. Recommended for the Northeastern and Lake States, also for cut over lands of the North and for the northern prairies.	Transplant seedlings 2–3 yrs. old. More rapid-growing than native spruce. Height at maturity 80-100 ft., diameter 2 3 ft.	Pure stands recommended; or mix with white or red pine, with European larch or chestnut.	Serves as a substitute for white pine. Extensively used as an ornamental tree.
Tamarack (*Larix laricina*) Case N	Wood hard, coarse-grained like red pine but stronger and stiffer; durable. Used for posts, ties, telegraph poles, canoes, spars and masts.	Will endure cold, wet situations. Recommended for planting throughout the northern states from the Atlantic to the Mississippi (up to elevation of 4000 ft.).	Grow seedlings in nursery beds, transplant when they are 2 3 years old. Rapid-growing. 45 feet height growth in 30 years.	Plant pure, or mixed with sugar maple or red oak or with spruce, balsam fir, or white pine.	The red tamarack of the market is the wood of trees grown on cold unfavorable sites.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Black Walnut (*Juglans nigra*) Case G, 7-8	Wood heavy, hard, strong; works well and takes a good polish; durable. Used for furniture, cabinetwork and interior finish especially in churches; for gunlocks, tool handles, carriage hubs; somewhat in ship building.	One of the most valuable of North American trees for planting in the fertile valleys of the Ohio and Mississippi and in the bottomlands of North and South Carolina, Georgia, Tennessee, Kentucky, Missouri, eastern Nebraska, Kansas and Oklahoma.	Transplant 1 yr. old seedlings from nursery; none but nursery method sure. Growth fairly rapid; 12–14 in. first year; post size in 10–12 yrs. saw timber in 40–60 yrs; May have annual diameter increase of 1 in. Bears fruit in 12–14 yrs.	Not shade-enduring. After the trees have 2–3 yrs. start, underplant with hardy catalpa, hackberry, Osage orange or box elder, shade-enduring trees which can be cut out in 20–25 years leaving the walnut to mature for saw timber.	Black walnut saw logs are exported to Europe, the best bringing very large returns. Autumn foliage bright lemon yellow.
White Willow (*Salix alba*) Case L	Wood soft, light, flexible fairly strong and durable. Used in slack cooperage; for charcoal used in gun powder manufacture; for cricket and baseball bats; for fuel where wood is scarce. Willow posts and poles last only 4–7 years unless treated.	White willow has proved successful for economic planting in rich sandy loam through the northern states south to Virginia and west to Kansas and the Dakotas. Especially recommended for the Ohio Valley and the Northern prairies.	Plant cuttings, spacing 2 or 3 ft. by 8 ft. Rate of growth depends on site, never as great as that of cottonwood. In lowlands, annual height growth 3 ft., diam. 1 in.; on uplands height growth 1½ to 2 ft., diam. ½ to ¾ in. Renew stand from stump sprouts.	Recommended for planting pure or in mixture with cottonwood. Best adapted for holding soil along streams (not along canals or irrigation ditches because the roots grow into the water).	Recommended for windbreaks. Willow produces 2–3 cords of firewood per acre annually on bottomlands. Autumn foliage yellow.

ARRANGEMENT, SELECTION AND CARE OF LAWN AND STREET TREES

WHEN planting trees about the home, arrangement and selection must be considered from other than the economic standpoint. For instance, instead of scattering trees over the lawn and grounds, it is better to mass them on two or three sides of the buildings as a frame for a picture, leaving open space centrally. In this, dense effects may be produced by filling in a lower story with shade-enduring trees or shrubs such as beech, sassafras, dogwood, witchhazel, tupelo, hornbeam and birch. Consider the view and plant no tall trees in position to obscure it. If the grounds are large, little mistake can be made if the picturesque effects of natural forestation are followed; that is, if a brook passes through the lawn droop willows over it, or if there is a small lake fill a point of land with them. If there is a rocky slope make it beautiful with hemlock and beech. Group birches so that they will be set off by a background of dark tree trunks or of evergreens (Fig. 54); plant the low ground-juniper in open stretches. Lombardy poplars add a conventional touch to the scene; locusts distract from the formal. An occasional isolated tree may be effective; oaks, elms, beeches, maples and many others make luxuriant growth when standing alone (Fig. 55). Add some evergreens in all artistic planting if only for the effect in winter. (Frontispiece.)

Plant many trees in cities. They not only give moisture and coolness to the air but also actually make it more fit to breathe by taking out its carbon dioxide and increasing its supply of oxygen (see Fig. 17, p. 20). Trees in congested city neighborhoods tend directly to diminish the summer death rate among children.

In planting along city streets the conventional row must be followed; but on country roads a more natural arrangement should prevail, groups of trees alternating with spaces left open for distant views. Mass tall sun-loving trees with lower shade-enduring trees or with shrubs, and in places allow wild grape and shrubby bittersweet to add their artistic presence. Why conventionalize country roadways? Conformity to the conventional must exist in most that greets our eyes — in city streets, in agricultural fields, in tree plantations. A country roadway may be orderly and yet have a natural arrangement of trees and shrubs, which will have the advantage also of making the place a more attractive rendezvous for our native birds.

FIG. 54. DECORATIVE BIRCHES

On the estate of the late Morris K. Jesup, Lenox, Massachusetts. Plant birches so that they are set off by the dark trunks of other tree or by evergreens

For street planting, deep-rooted trees, like sugar or Norway maple, liquidambar or tupelo are best. They suffer least from having their roots covered by the solid substance of walks and roadbeds. Choice should fall more often on oaks for city streets; they take longer to attain large size, but the result pays for the waiting. Silver maple is often used, but like the box elder is fragile in storms and is short-lived. Some of the best trees for broad thoroughfares in the eastern United States are American elm, tulip-tree, tupelo or pepperidge, honey locust, sycamore, sugar maple and scarlet oak. Tupelo and scarlet oak in autumn are particularly attractive because of their brilliant red foliage. Asiatic trees much used for streets and lawns are ginkgo, horsechestnut, ailanthus and the magnolias. They are worth the attention they receive, except the ailanthus, which, however, has the advantage of growing under extremely adverse conditions.

Very often a sort of care can be given to shade and street trees impossible in the forest and under the conditions of economic forestry. They can be kept in good health, pruned, kept wholly free from insects, supplied with fertilizer and with the proper amount of water, and even artificially strengthened. In pruning, it is best to remove not only dead branches but also living ones to such an extent that there will be left space for the suitable development of those remaining. In removing a branch, cut close to the trunk so that the bark can grow over the wound quickly, preventing the commencement of a cavity through the decay of a stub. Cut through the bark below and at the sides first so that there will be no unnecessary stripping off of bark when the branch falls. If trees are artificially watered, avoid keeping the ground continually wet, but let it dry out between times. When roots are surrounded by water, oxygen cannot reach them, and if this condition continues, the trees die from their inability to breathe. A method has arisen in "tree surgery" by which hollow tree-trunks are filled with cement, all dead wood being first cut out and the cavity coated with antiseptic. There is no doubt that the process may lengthen the life of a tree tens or scores of years. Many great elms, the pride of Concord, Massachusetts, are interesting examples of such treatment.

FIG 55. TULIP-TREE IN NEW YORK BOTANICAL GARDENS

Many trees make luxuriant growth when standing alone. The largest tulip-trees known have measured 190 ft. in height and 10 ft. in diameter. This species cannot endure shade and in the forest prunes itself of side branches. Forestry Hall, Case A, 3

APPENDIX I.

HOW TO RECOGNIZE A FEW EASTERN BROADLEAF TREES IN WINTER.

Artificial Key to the Twigs.

A. Twigs with alternate buds
 B. Twigs with dark bark.
  C. More or less slender and flexible: .... I pp. 86 to 91.
  CC. More or less stout and stiff: .... II pp. 91 to 93.
 BB. Twigs with light bark.
  C. More or less slender and flexible: .... III pp. 93 to 95.
  CC. More or less stout and stiff: .... IV pp. 95 to 97.
AA. Twigs with opposite buds.
 B. With dark bark: .... V pp. 97 to 98.
 BB. With light bark: .... VI pp. 98 to 99.

I. *Beech, Chestnut, Wild Cherry, Birch, Alder, Elm, Linden and Locust: Trees whose slender and flexible twigs have alternate buds and dark bark.* The twigs of these trees resemble one another closely and are more difficult of recognition than all others.

1. **Beech** (*Fagus americana* Sweet). Beech twigs are known by their unusually long and slender, pointed buds which have many overlapping scales (Fig. 56). The twigs are smooth and reddish brown, and are bent at the points of attachment of the buds. The tree is recognized also by the clean and smooth gray bark of the trunk.

2. **Chestnut** (*Castanea dentata* Borkh.). Chestnut twigs of recent growth have strong ridges extending downward from the leaf scars (Fig. 57). The rounded buds are light brown, have few scales and extend from the twig at an angle of somewhat less than 45°. The bark of the twigs and young shoots is smooth and shining. The bark of the trunk is coarsely ridged lengthwise.

3. **Wild Cherry or Black Cherry** (*Prunus serotina* Ehrh.). The Wild Cherry has rigid-looking stems which are flexible when bent but which break when bent sharply. The small scaly and pointed buds hug the stems closely.

FIG. 56. BEECH TWIG
Known by its slender and pointed brown buds

FIG. 57. CHESTNUT TWIG

Twigs of recent growth have ridges extending downward from the leaf scars

The broken twigs have a peculiarly pungent, bitter flavor and odor. The bark of the trunk is reddish brown and smooth when the tree is young, but scales off in thin fragments as the tree becomes older. The bark resembles that of the black birch but can be distinguished from it by the presence of conspicuous lenticels (breathing structures).

4. **American Gray Birch** (*Betula populifolia* Marsh). The twigs of the gray birch are slender and flexible. They are very tough. The new twigs are rough to the touch. The buds extend at an angle somewhat less than 45° and the twigs are bent where the buds are attached (Fig. 58). The gray birch is characterized by its sprout growth, that is, it seems to have several trunks which start out close together at the ground or near it (Fig. 59). This birch grows in very poor soil, and we associate it with scrub oaks, sumachs, barberries, red cedars and other low trees and shrubs bordering forests and occupying waste land. The white bark of the tree is chalky to the touch; it does not peel from the trunk but remains smooth as the tree grows old. There are conspicuous triangles of dark color on the trunk below the points of insertion of the branches.

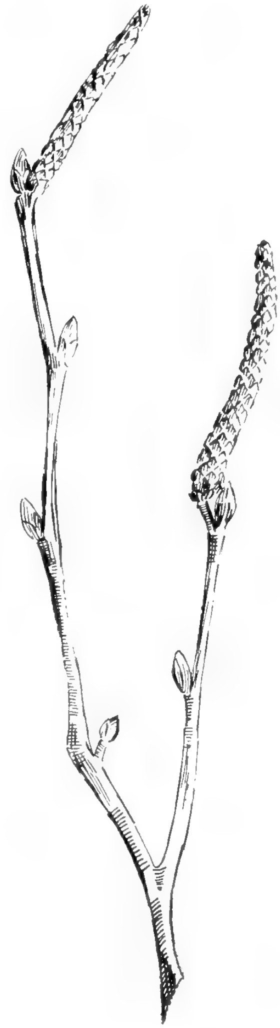


FIG. 58. GRAY BIRCH

Gray Birch twigs are rough to the touch and are bent at the points where the buds grow. Rigid, staminate catkins show their winter condition

Canoe, Paper or White Birch (*Betula papyrifera* Marsh) can be distinguished

from the gray birch by the fact that the white shining bark of the trunk continually splits into thin layers and is frayed in the wind. The white birch grows to great size.

Black Birch (*Betula lenta* L.) has twigs of golden brown color and aromatic flavor, differing from those of the gray birch in being brittle instead of tough. The tree can be distinguished also by the bark of the trunk, which is likely to be smooth and reddish brown like that of the cherry, but lacks the horizontal lenticels of the cherry; it never frays into strips when old.

FIG. 59. GRAY BIRCH IN WINTER

FIG. 60. YELLOW BIRCH

The bark may be frayed into a tangle of ribbons

FIG. 61. WHITE ELM TWIGS

Some results of a gray squirrel's pruning. He bit off the twigs and ate the flower buds. In the spring the tree seemed in as full leaf as its neighbors

FIG. 62. BASSWOOD

Smooth and brown twigs with fat reddish brown buds

Yellow Birch (*Betula lutea* Michx.). The twigs of yellow birch are less aromatic than those of black birch. The buds are sharp-pointed, light chestnut brown and about one-fourth inch long. The bark is yellow and separates into thin pieces (Fig. 60).

5. **American or White Elm** (*Ulmus americana* L.). The twigs of the white elm (Fig. 61) are difficult of recognition. They are smooth and dark-colored, almost lacking the white spots so conspicuous on many twigs. The small brown buds are scaly and pointed. The alternate branches are given off at right and left in a horizontal plane, are about equal in length, and, although they are not quite at right angles and not opposite like those of red maple, nevertheless at first glance they give the appearance of a miniature telegraph pole with cross-bars; sprays of this character are conspicuous near the top of the tree. The white elm is easily recognized in winter by the vase shape of the tree and the delicacy of the spray.

Slippery Elm (*Ulmus fulva* Michx.) can be distinguished from the white elm by the large size and downy character of its buds and by its mucilaginous inner bark.

6. **Linden or Basswood** (*Tilia americana* L.).

The twigs are smooth and brown, not conspicuously dotted with white. The fat reddish brown buds have few scales and project from the stem at an angle of 45°. The terminal bud is often lacking. The twigs may show the bending at the points of attachment of buds as in the gray birch (Fig. 62). The bark on the trunk is dark and furrowed. The basswood sprouts

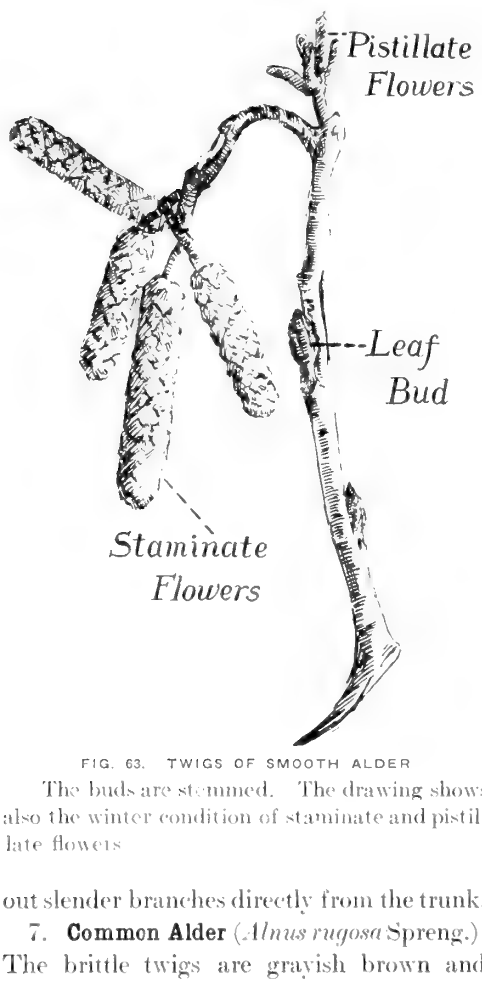


FIG. 63. TWIGS OF SMOOTH ALDER

The buds are stemmed. The drawing shows also the winter condition of staminate and pistillate flowers

FIG. 64. WHITE HICKORY TWIG

The terminal bud is always largest. Tough, smooth twigs showing conspicuous lenticels

out slender branches directly from the trunk.

7. **Common Alder** (*Alnus rugosa* Spreng.). The brittle twigs are grayish brown and smooth, with scattered light spots. Alder can be known by the fact that the smooth oval buds are on short stems of their own. The buds project at an angle of 45° or less (Fig. 63). This alder and the more north-

ern species, Speckled Alder (*Alnus incana* Willd.), grow along brooks and about marshes. The twigs of the latter can be distinguished from those of the former by their downy appearance and by the large number of light-colored lenticels which give the name "Speckled" to the species. These alders seldom reach a height of more than twelve to fourteen feet.

8. **Common Locust** (*Robinia pseudacacia* L.). The recognition of locust twigs presents no difficulty. The twigs are slender, smooth and brown, ridged lengthwise and furnished with pairs of thorns. Between the individual thorns of each pair is a bud almost hidden in the center of a leaf scar: each leaf stem of the locust is hollow at its base and fits over a bud, so that no buds are visible until the leaves have fallen. The bark of the tree is rough and furrowed.

II. *Hickory and Oak: Trees with more or less stout and stiff twigs having alternate buds and dark bark.*

1. **Mockernut or White Hickory** (*Hicoria alba* Britt.). This hickory can be recognized by the large buds which are hard and round with few downy brown scales. The terminal bud is always largest; the lateral buds extend at an angle of 45° or more (Fig. 64). The tough twigs are smooth and reddish brown, and have conspicuous white lenticels. The older twigs are dark gray. The mockernut hickory is a large tree with bark showing wavy furrows.

Shagbark Hickory (*Hicoria ovata* Britt.) has buds with dark scales. The bark on the trunk "shags" off when old.

Pignut Hickory (*Hicoria glabra* Britt.) has twigs that are smooth and greenish brown; they may be somewhat angled.

2. **White Oak** (*Quercus alba* L.) can

FIG. 65. OAK BUDS

Braided in appearance due to the arrangement of the scales. white oak buds are rounded; black oak, pointed.

be distinguished by its rounded buds, which have a braided appearance given by the many closely overlapping scales (Fig. 65, twig at left). Lateral buds are crowded about the terminal bud, producing a cluster. The leaf scars project from the twig. The leaves, which have rounded lobes, are likely to remain on the tree throughout the winter. The "sweet" acorns are in shallow, rough cups. The bark on the trunk of the tree is light-colored and rough.

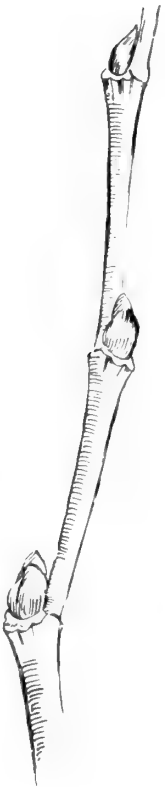


FIG. 66. BUTTONWOOD TWIG

Conical brown buds are in the centers of the leaf scars

FIG. 67. THE TRUNK OF A YOUNG BUTTONWOOD TREE

Black Oak (*Quercus velutina* Lam.). The large buds (Fig. 65, twig at right) are sharp-pointed and somewhat downy. The twigs are smooth and have a bitter taste. The "bitter" acorns are in deep cups. The bark on the trunk is dark in color. "Oak apples" are found on black oaks.

The white oak, swamp white oak, chestnut oak, post oak and some others, are white oaks, recognized by the light bark of their trunks and the rounded lobes of their leaves. They are difficult of distinction from one another in their winter condition.

The black oak, scarlet oak, red oak, scrub oak and a few others, are black oaks known by the dark bark of their trunks and by the pointed lobes of their leaves. They also are distinguished from one another with difficulty in winter.

III. *Willow, Poplar, Buttonwood: Trees whose light-colored twigs have alternate buds and are more or less slender and flexible.*

1. **White Willow or Golden Osier** (*Salix alba* var. *vitellina*). The twigs of this willow are light yellow in color, smooth, tough, and very flexible. The pointed buds hug the stem; each is covered by a single scale in the form of a peaked cap which may look as though empty at

FIG. 68. BUTTERNUT TWIG

Shows leaf buds only. The lateral leaf buds are stemmed

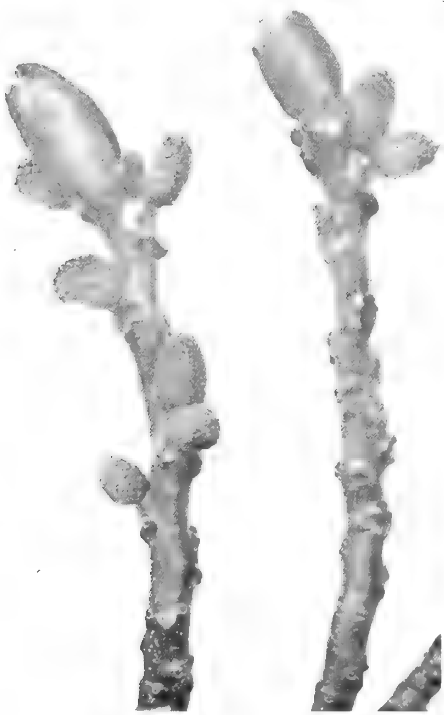


FIG. 69. BUTTERNUT TWIGS

Showing staminate flower buds

FIG. 70. BLACK WALNUT

Leaf and flower buds. The leaf scars lack the downy ridge conspicuous in butternut

the top. This tree, naturalized from Europe, is very common along streams and marshes. The many native varieties of willow are difficult of recognition even when they have flowers or leaves.

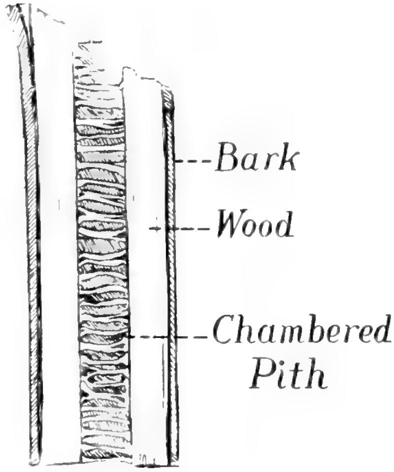


FIG. 71. BUTTERNUT TWIG

Longitudinal section to show the chambered pith

2. **American Aspen** (*Populus tremuloides* Michx.). The twigs of the American aspen are greenish gray and smooth. The pointed buds are long and covered with glossy, gummy scales. The tree is a small one with smooth greenish gray bark.

Large-toothed Aspen (*Populus grandidentata* Michx.) has the same smooth greenish gray bark as has the American aspen, but is a tree of smaller size. Its pointed buds are downy instead of smooth and they extend at right angles from the twig.

Balsam Poplar (*Populus balsamifera* L.) can be recognized by its coarse, ridged twigs and by the large sticky buds which have an unusually sweet odor.

3. **Sycamore, Plane-tree, or Buttonwood** (*Platanus occidentalis* L.). The light-colored smooth twigs are rigid in appearance. The conical brown buds are in the centers of the leaf scars, being formed within the hollow bases of stems and not showing until the leaves fall (Fig. 66). The outer board-like scale covers light-brown silky scales of great beauty. The tree can be known by the bark which comes off in plates, leaving smooth green or white spots (Fig. 67). The balls of fruit hang on the tree all winter.

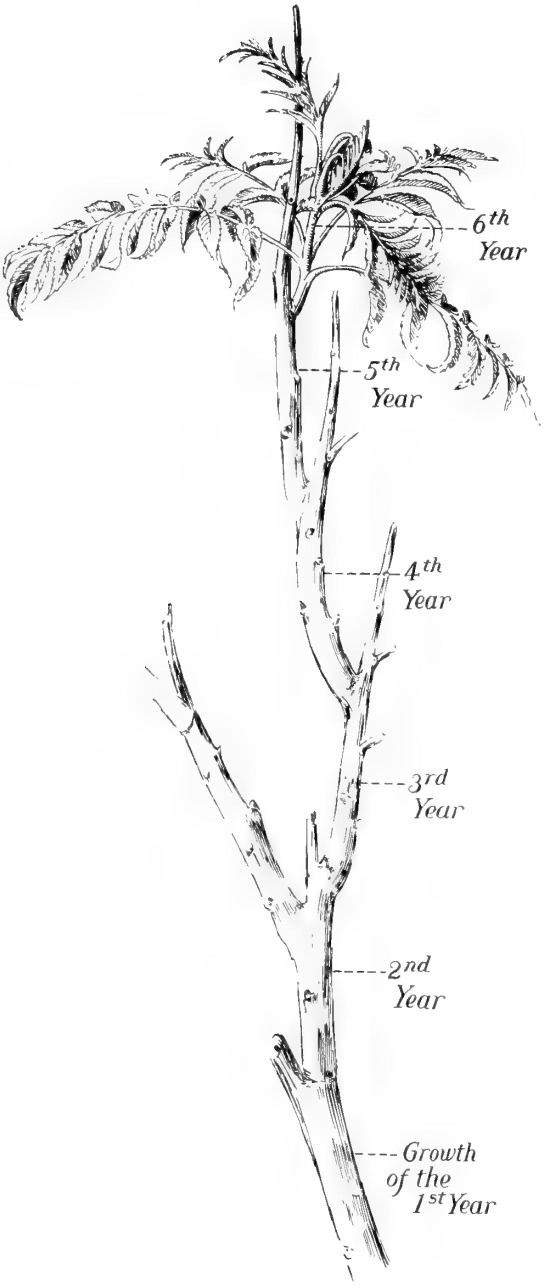


FIG. 72. GROWTH OF THE SMOOTH SUMACH

Recognized in winter by means of its tapering twigs with their dead ends

IV. *Butternut, Sumach, Poison Sumach, Ailanthus, Sassafras, Sweet Gum: Trees or shrubs with light-colored, more or less stout and rigid twigs having alternate buds.*

1. **Butternut** (*Juglans cinerea* L.) can be known in winter by its long, yellowish brown naked buds (Figs. 68 and 69). The terminal bud is much larger than the lateral buds and shows outer reduced leaves which are woolly. The lateral buds are stemmed, and have one or more smaller buds between them and their respective leaf scars. The leaf scars are large and contain three distinct U-shaped scars. Each leaf has a downy ridge above it. The pith consists of transverse chambers, between brown walls, easily seen when the twig is split lengthwise (Fig. 71). The butternut is a large tree with coarse light bark.

Black Walnut (*Juglans nigra* L.) resembles the butternut, but can be distinguished by the gray color

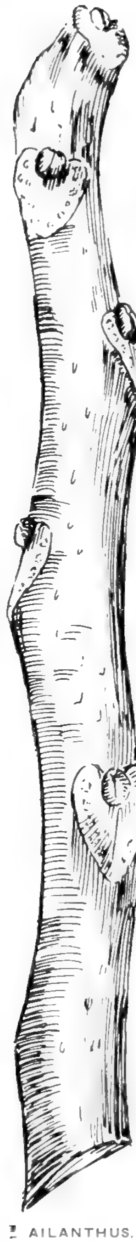


FIG. 73. ½ AILANTHUS, OR TREE OF HEAVEN

Large heart-shaped leaf scars; buds small, two-scaled

of the buds and by the absence of the downy ridge above the leaf scar (Fig. 70).

2. **Scarlet or Smooth Sumach** (*Rhus glabra* L.) has light-colored, smooth stems which are straight and stiff, tapering to a more slender dead end (killed by the frost, or perhaps the remains of the fruit cluster). The buds are small and project from the centers of the leaf scars, being like those of locusts and buttonwoods in this respect.

Sumach of any variety can be recognized in winter by its spreading shape and curious tapering twigs with dead ends. The age of a sumach can be readily told at considerable distance by the curious method of branching from the one to four strongest buds (Fig. 72). The smooth sumach and the staghorn sumach (*Rhus hirta* Sudw.) carry pyramids of scarlet fruit throughout the winter, furnishing food for crows and other birds. The staghorn sumach can be distinguished from the smooth sumach by the dark velvet covering on its stems.

3. **Poison Sumach** (*Rhus vernix* L.). The grayish brown twigs of the poison sumach have extremely small buds above large reddish brown leaf scars that are conspicuously hollowed out. This sumach grows in wet places and has hanging, loose clusters of white berries, which adhere through the winter. This is the most venomous poison among our woody plants.

Poison "Ivy" or Poison "Oak" (*Rhus toxicodendron* L.) is a sumach of vine habit, either climbing fence posts, trees and the like (*Rhus radicans*), or trailing over the ground in a dense carpet (*Rhus microcarpa*).

4. **Ailanthus or Tree of Heaven** (*Ailanthus glandulosa* Desf.). The coarse and sturdy-looking but brittle ailanthus twigs (Fig. 73) have very light bark and conspicuous white

lenticels; the alternate leaf scars are large, more or less heart-shaped, and show many small scars where woody fibres broke away. The buds are small, two-scaled. The pith in the twigs is brown and extensive.

5. **Sassafras** (*Sassafras sassafras* Karst.). The yellowish green, rigid-looking twigs are arranged in bushy sprays. They are brittle and when broken give off an aromatic odor. The terminal buds, which include leaves and flowers, are prominent throughout the winter.

6. **Sweet Gum** (*Liquidambar styraciflua* L.). The young twigs are yellowish in color; the buds are reddish brown and glossy. If the twigs show the blade-like ridges of bark characteristic of sweet gum, the matter of the tree's identity is settled at once.

V. *Horsechestnut and Maples: Trees with dark-colored twigs and opposite buds.*

1. **Horsechestnut** (*Æsculus hippocastanum* L.). The dark twigs are coarse and stout, with prominent opposite leaf scars (Fig. 74). The large brown and scaly terminal buds are covered with a gummy substance. The old bark of the tree breaks away in smooth, square pieces.

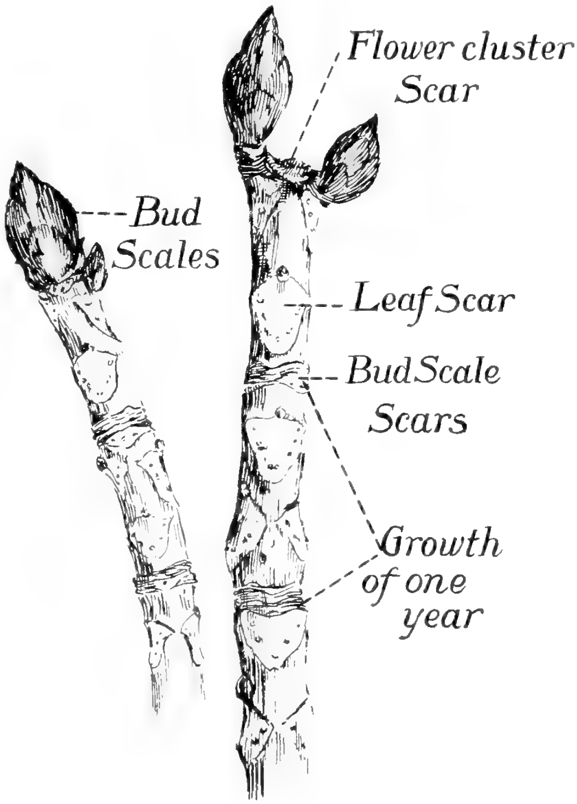


FIG. 74. HORSECHESTNUT TWIG

2. **Red Maple** (*Acer rubrum* L.). Branches, leaf scars, and buds are opposite (Figs. 75 and 76). Spherical flower buds, red in color, may be clustered around the stem adjacent to the leaf buds. Young twigs are red;

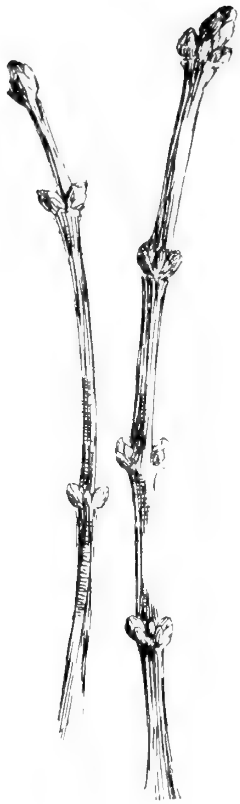


FIG. 75. LEAF BUDS OF RED MAPLE

Twigs of latest growth are red; older twigs are brown

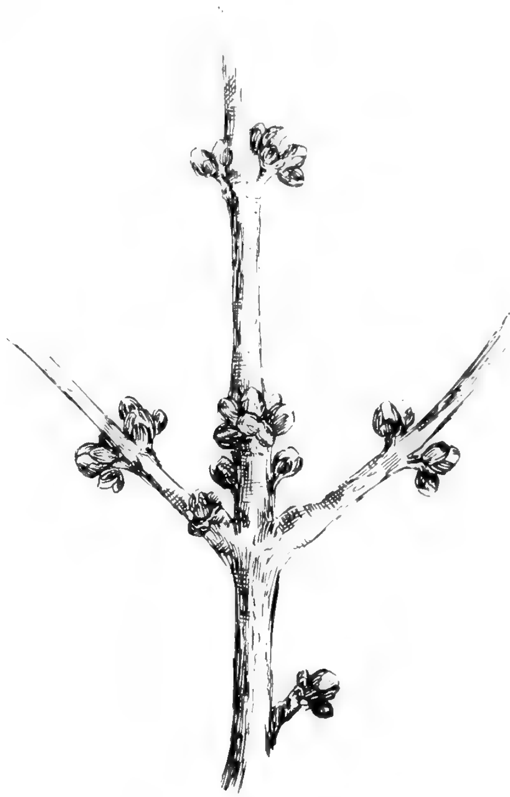


FIG. 76. FLOWER BUDS OF RED MAPLE

Branches, buds, and leaf scars are opposite

older ones, brown. The twigs are often curved like the pendulous twigs of the Silver Maple (*Acer saccharinum* L.). The old bark is smooth and gray, sometimes cracked lengthwise.

3. **Sugar Maple** (*Acer saccharum* Marsh.) has sharp-pointed and scaly brown buds. The old bark is broken into long fissures, having a "ploughed" appearance.

VI. *White Ash, Elderberry, etc.: Trees or shrubs having light-colored twigs and opposite buds.*

1. **White Ash** (*Fraxinus americana* L.). Twigs with light-colored smooth bark; branches, leaf-scars and buds opposite (Fig. 77). The ter-

minal bud (rusty in color) is largest and has but few scales. The stems are flattened at the joints. The old bark is furrowed into diamond-shaped spaces.

Red Ash (*Fraxinus pennsylvanica* Marsh.) can be distinguished by the down on the new shoots. The twigs are relatively slender and are more branched than those of white ash. The buds are dark-colored.

Black Ash (*Fraxinus nigra* Marsh.) twigs are not conspicuously flattened at the joints, they have greenish bark; the buds are black in color. The tree grows in wet places.

2. **American Elder or Elderberry** (*Sambucus canadensis* L.). The opposite buds are small and nearly naked. The twigs are tapering and dead at the tips (compare with sumach, p. 95). The branching is opposite from lateral buds. The American elder seldom reaches a height greater than twelve feet.

FIG. 77. WHITE ASH TWIG

Opposite leaf scars and buds. Twig flattened at the joints

APPENDIX II

KEY TO SOME OF THE CONE-BEARING TREES OF EASTERN FORESTS AND PARKS

A. Leaves not on the tree through the winter. . . . . .Larch
(*Larix americana* Michx.)

AA. Leaves on the tree and green through the winter.

- B. Leaves in bundles.
  - C. Leaves five in a bundle. . . . . .White Pine (*Pinus strobus* L.)
  - CC. Leaves fewer than five in bundle.
    - D. Leaves three in bundle. . . . . .Pitch Pine (*Pinus rigida* Mill.)
    - DD. Leaves two in bundle.
      - E. Leaves 4–6 inches long.
        - F. Leaves flexible from long conspicuous sheathes. Red Pine (*Pinus resinosa* Ait.)
        - FF. Leaves very stiff. . . . . .Austrian Pine (*Pinus laricio* var. *austriaca* Endl.)
      - EE. Leaves less than two inches long.
        - F. Cones point outward and downward. . . . . .Scotch Pine (*Pinus sylvestris* L.)
        - FF. Cones point upward. . . . . .Scrub Pine (*Pinus banksiana* Lamb.)
- BB. Leaves single in attachment to twig.
  - C. Leaves attached alternately all around twig.
    - D. Leaves extending in all directions from twig.
      - E. Leaves four sided, sharp pointed.
        - F. Leaves bluish green; cones ½ to 1½ in. long, persistent for many years. . . . . .Black Spruce (*Picea mariana* B. S. & P.)
        - FF. Leaves yellowish green; cones 1 to 2 in. long, beginning to fall as soon as the scales open. . . . . .Red Spruce (*Picea rubens* Sarg.)
      - EE. Leaves flat, blunt. . . . . .Fir Balsam (young branch) (*Abies balsamea* Mill.)
    - DD. Leaves spreading at sides of twig in two ranks.
      - E. Leaves along top of twig minute. . . . . .Hemlock (*Tsuga canadensis* Carr.)
      - EE. Leaves along top of twig not reduced in size. Fir Balsam (old branch) (*Abies balsamea* Mill.)
  - CC. Leaves attached opposite each other or in whorls closely covering the twig.
    - D. Spray flat.
      - E. Cones opening to the base at maturity; scales thin. Arborvitæ (*Thuya occidentalis* L.)
      - EE. Cones never opening to the base; scales thick and beaked. White Cedar (*Chamæcyparis thyoides* Britt.)
    - DD. Spray 4-angled. . . . . .Red Cedar (*Juniperus virginiana* L.)

INDEX

Page numbers of illustrations are set in heavy face type

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price,* 15 *cents.*

(Reprinted from The American Museum Journal)

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1905. *Out of print.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Out of print.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price,* 15 *cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Price,* 10 *cents.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price,* 15 *cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Out of print.*

(Published as a separate series)

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price,* 10 *cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Out of print.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price,* 10 *cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Price,* 15 *cents.*

No. 28.— THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price,* 15 *cents.*

No. 29.— THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909. *Price,* 10 *cents.*

No. 30.— THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO. November, 1909. *Price,* 5 *cents.*

No. 31.— BRIEF HISTORY OF ANTARCTIC EXPLORATION. March, 1910. *Price,* 10 *cents.*

No. 32.— TREES AND FORESTRY. By MARY CYNTHIA DICKERSON, B. S., Curator of Woods and Forestry. September, 1910. *Price,* 25 *cents.*

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY

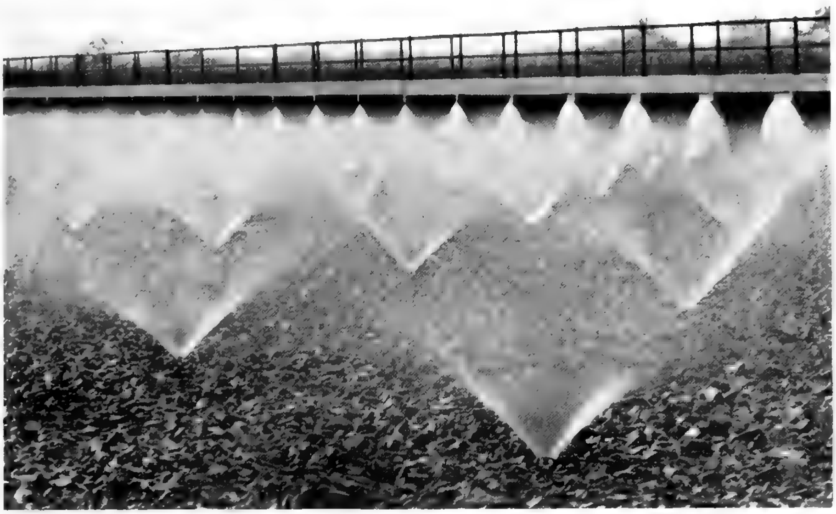
For Sale at the Museum

(Issued as supplements to The American Museum Journal)

(Continued on page 3 of cover.)

AMERICAN MUSEUM OF NATURAL HISTORY

Protection
OF
River and Harbor Waters from Municipal Wastes



TRICKLING FILTERS, COLUMBUS, OHIO

By CHARLES-EDWARD AMORY WINSLOW

Curator of Public Health

GUIDE LEAFLET NO. 33

APRIL, 1911

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

The Museum is Open Free to the Public on Every Day in the Year.

The American Museum of Natural History was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world. The membership fees are,

Annual Members	$ 10	Fellows	$ 500
Sustaining Members (Annual)	25	Patrons	1000
Life Members	100	Benefactors (Gift or bequest)	50,000

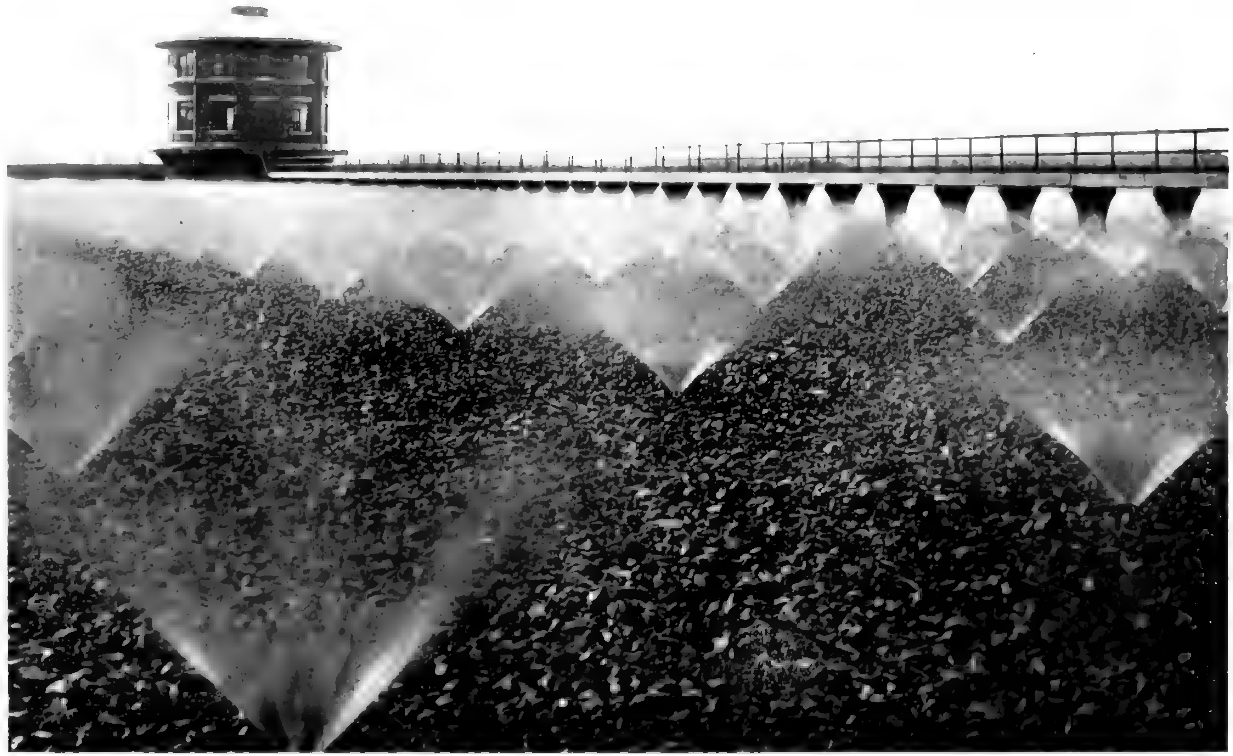
The Museum Library contains more than 60,000 volumes with a good working collection of publications issued by scientific institutions and societies in this country and abroad. The library is open to the public for reference daily — Sundays and holidays excepted — from 9 a. m. to 5 p. m.

The Museum Publications are issued in six series: The American Museum Journal, Annual Report, Anthropological Papers, Bulletins, Guide Leaflets and Memoirs. Information concerning their sale may be obtained at the Museum Library.

Guides for Study of Exhibits are provided on request by the Department of Public Education. Teachers wishing to bring classes should write or telephone the Department for an appointment, specifying the collection to be studied. Lectures to classes may also be arranged for. In all cases the best results are obtained with small groups of children.

Workrooms and Storage Collections may be visited by persons presenting membership tickets. The storage collections are open to all persons desiring to examine specimens for special study. Applications should be made at the information desk.

The Mitla Restaurant in the east basement is reached by the elevator and is open from 12 to 5 on all days except Sundays. Afternoon Tea is served from 2 to 5. The Mitla Room is of unusual interest as an exhibition hall being an exact reproduction of temple ruins at Mitla, Mexico.



TRICKLING FILTERS, COLUMBUS, OHIO

By means of fixed sprinkler nozzles, sewage is sprayed evenly over the surface of a bed of coarse stone. This method is at present considered one of the most effective of all devices for sewage purification

Protection of River and Harbor Waters from Municipal Wastes

WITH SPECIAL REFERENCE TO THE CONDITIONS IN NEW YORK

BY

CHARLES-EDWARD AMORY WINSLOW, M. S.
Curator of Public Health

NEW YORK
Published by the Museum
April, 1911

NO. 33

OF THE

GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

MARY CYNTHIA DICKERSON, Editor

PROTECTION OF RIVER AND HARBOR WATERS FROM MUNICIPAL WASTES

WITH SPECIAL REFERENCE TO THE CONDITIONS IN NEW YORK

THE PROBLEM OF SEWAGE DISPOSAL

CITY life presents pressing and peculiar biological problems. When a large number of human beings are concentrated upon a small area the fundamental needs of individual life must be met by new means. Special measures must be adopted for getting food from a wide radius into the center where so much of it is to be consumed. The spread of epidemics which always threaten crowded communities must be guarded against; and the waste products which accompany all living processes must be removed.

This last task, the removal of the city's wastes, is one of the most difficult which confronts a modern municipality. From every large city there pours out a river of waste material which pollutes streams, harbors and foreshores, spoiling what should be the chief pleasure spots of the city and damaging property values, if it does not actually threaten human life and health. By the modern methods of sanitary science these liquid wastes can be purified and rendered harmless and it is with such methods of protecting the purity of inland and seaboard waters that a section of the Public Health Exhibit of the American Museum now deals.

City sewage is a far less offensive substance than might be imagined. To the sight it is simply a grayish liquid with fine f[illegible] suspended matter in it; to the smell it is inoffensive when fresh, having only a faint musty odor. Analysis shows that the average American sewage contains less than one part in a thousand of solid matter, the rest being water. Of the solid matter half is of mineral nature, so that only a residuum of perhaps four-hundredths of one per cent of organic matter requires especial treatment. It is the vast volume of the sewage stream however, which makes the problem such a serious one. For example, there is now discharged into New York harbor about 500 million gallons of sewage a day. This amount of liquid if concentrated in one place, would fill East River under the Brooklyn Bridge for a distance of one-fifth of a mile. Even four-hundredths of one per cent

of this immense mass of liquid amounts to 800 tons; and this is approximately the amount of organic matter discharged into New York Harbor every day.

The organic matter in sewage, which is the principal source of embarrassment in its disposal, is made up for the most part of imperfectly oxidized unstable molecules which may undergo one or the other of two different series of changes. First, it may decompose or putrefy in the absence of oxygen, with the production of offensive gaseous compounds. Or secondly, under the influence of oxygen it may undergo another process — that of nitrification, a slow burning or combustion which converts the organic matter into nitrates or other mineral substances, without the production of foul odors and in a wholly innocuous way.

Where sewage is discharged without due precautions into the nearest watercourse, the first sort of change is likely to result. If the volume of the sewage in relation to the stream be small, there may be enough oxygen present to care for the organic matter. If, on the other hand, the volume of sewage exceeds the purifying capacity of the stream (which may be taken as about one part of sewage in fifty parts of water) the whole process changes: instead of self-purification, there is putrefaction. Decomposable organic matter accumulates on the bottom and the whole stream or pond is turned into a fermenting pool, the odor from which may produce a serious nuisance for considerable distances from its banks. Conditions like these now exist within the limits of Greater New York in such places as the estuaries of the Gowanus Canal and Newtown Creek.

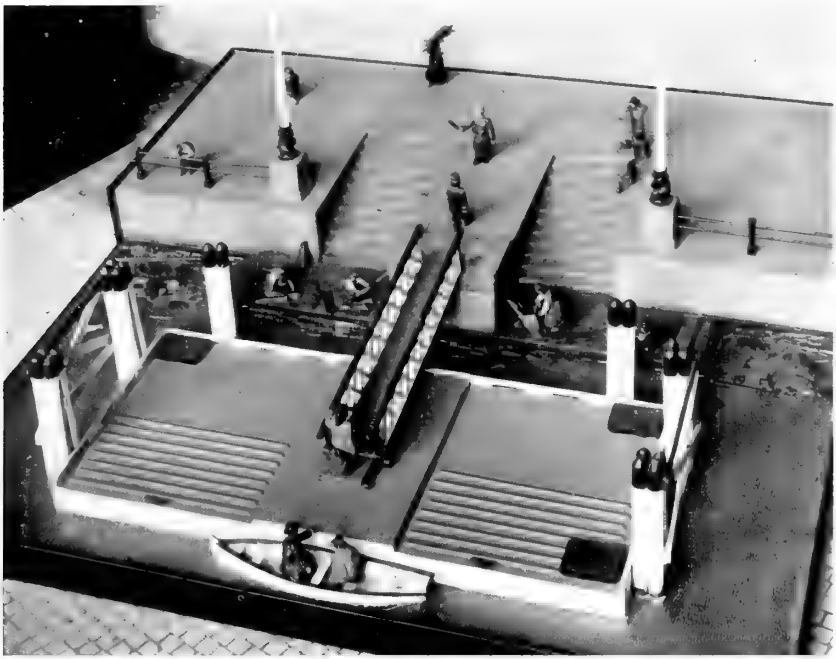
CONDITIONS IN NEW YORK HARBOR

New York is more fortunate than most cities in its insular position and in the large bodies of water which wash its shores. Even here however, the present methods of disposal by the haphazard discharge of some sewers at the piers or bulkhead lines is manifestly unsatisfactory. So far as the harbor waters as a whole are concerned, it must be noted that the amount of diluting water available is much less than would at first sight appear. The hourly variations are great. Over 3000 million cubic feet of water pass through the Narrows in a single hour at the maximum period of flood.[1] The total ebb at this point is 12,213 million cubic feet; but the

[1] Data in regard to conditions in New York Harbor are quoted from the *Report of the Metropolitan Sewerage Commission*, 1910.

total flood is 11,030, so that the net outflow is proportionately small. In the Hudson River the ebb is 6,910 million cubic feet and the flood 5,740 million. In the East River the figures are respectively 4,068 million and 3,968 million cubic feet and in the Harlem River 176 million and 153 million. The result is that most of the sewage oscillates back and forth instead of passing promptly out to sea.

The general effect of this pollution is manifest in the reduced oxygen content of the harbor. The East River above Hell Gate contains on the



Gathering driftwood from the polluted waters about the steps of the Battery. Photograph from a model in the American Museum

flood tide 92 per cent and on the ebb tide 80 per cent of the oxygen necessary for saturation. Below Hell Gate the values fall to 69 per cent on the flood and 60 per cent on the ebb. In the Hudson River above Spuyten Duyvil there is about 84 per cent of the oxygen necessary for saturation, on both tides; below Spuyten Duyvil the figure falls to 76 per cent on the flood and 66 per cent on the ebb. Samples taken from the eastern end of the Harlem show on the average only 43 per cent of the oxygen necessary for saturation on the flood tide and only 27 per cent on the ebb. The upper East River

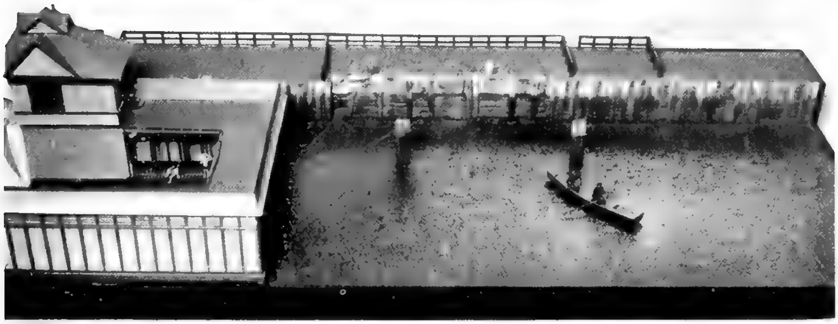
and the upper Hudson are in general in fair condition; the lower sections of these rivers adjoining Manhattan Island are considerably polluted; and the Harlem River is grossly polluted. In the immediate vicinity of sewer outlets the conditions which exist are distinctly offensive to the senses.

Besides these conditions of local nuisance, there are real dangers to health involved in the present method of disposal of New York sewage. The wastes from a city always contain the germs of such infectious diseases as typhoid fever, and those who come in contact with water into which such wastes are discharged are liable to contract the diseases in question. More or less contact is inevitable with the waters immediately surrounding the shores and docks. Thus at the steps in Battery Park and all about the

CLAM DIGGING NEAR SEWER OUTLET, JAMAICA BAY

Shellfish procured from this and similar localities are sold in the city's markets and are occasionally responsible for cases of typhoid fever. Photograph of a model in the American Museum

city, driftwood and other floating objects are picked out and carried by the poor to their homes. All these objects have been exposed to dangerous pollution and may carry the germs of disease. In Jamaica Bay and elsewhere near New York, clams and other shellfish are taken in the near neighborhood of public and private sewers. Some processes of cookery destroy the germs of typhoid but others do not. The amount of disease now caused in this way is probably not large but the danger exists. The most serious of these sanitary problems is that due to bathing in the polluted waters. Free floating bathing establishments are maintained by the City at various points along the water front, often in the near vicinity of

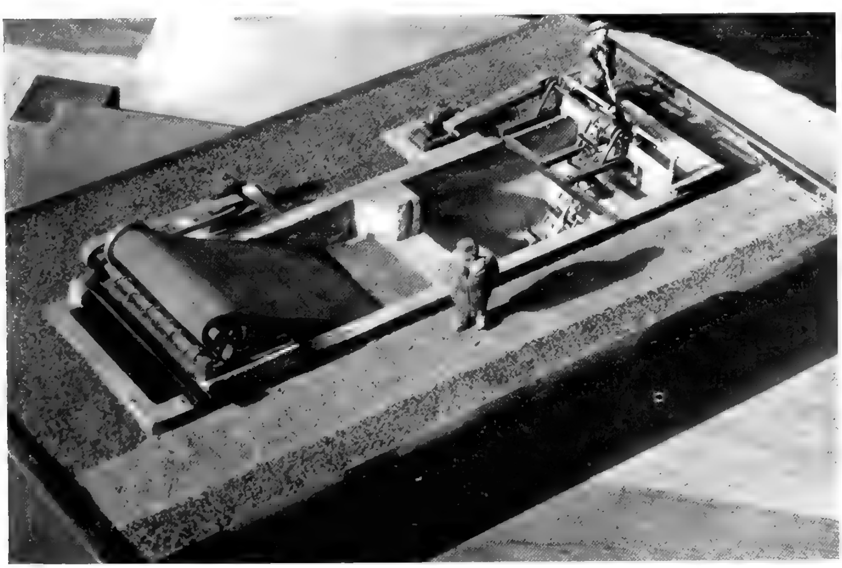


A MUNICIPAL BATHING-PLACE

Free floating baths at various places along the waterfront are placed in close proximity to sewer outlets, thus menacing the lives of many who frequent these baths during the summer months. Photograph of a model in the American Museum

sewer outlets. It cannot be doubted that such conditions furnish excellent opportunities for infection of various sorts.

The safe and inoffensive disposal of the wastes of a large city is a difficult but by no means an insuperable task. It involves one or more of three main processes, according to local conditions — namely, the elimination of



Fine mesh revolving screen and detritus tank for removing suspended solids from sewage. Photograph of a model in the American Museum

Courtesy of J. D. Watson

FINE MESH REVOLVING SCREEN AT BIRMINGHAM, ENGLAND

These screens constantly revolve so that a fresh surface is always ready for use

suspended solids, the oxidation of unstable organic compounds and the destruction of pathogenic bacteria.

SCREENING OF SEWAGE

The first problem in almost every case is the elimination of the coarser floating particles by some form of straining or screening. Sometimes this is accomplished roughly by the use of coarse bar screens with bars half an inch or an inch apart. In England and Germany finer screens of wire cloth with meshes as close as a tenth or even a twenty-fifth of an inch have been used. Such screens are frequently arranged to revolve like an endless belt, so that a fresh area is constantly brought into action and the accumulated screenings are carried upward and automatically brushed off into a trough.

Where it is necessary to remove a larger proportion of suspended solids than can be held back by screening, sedimentation is the next process called into play. Screening alone is sufficient for all practical purposes in some cases, so in others screening and sedimentation will produce an effluent pure enough to be discharged into adjoining waters. As a preliminary to the processes used for final purification, sedimentation almost always plays a part.

SEDIMENTATION

The purifying action of a sedimentation tank depends on the physical factors of velocity and time. If the dimensions of the tank are such that the flow is reduced only to a rate of thirty feet per minute the heavy mineral matter — gravel, sand and the like — will be removed but the finer organic particles will not be affected. Such a small tank as this is known as a detritus tank or grit chamber, and forms a part of practically all sewage works, generally in intimate connection with the screening process.

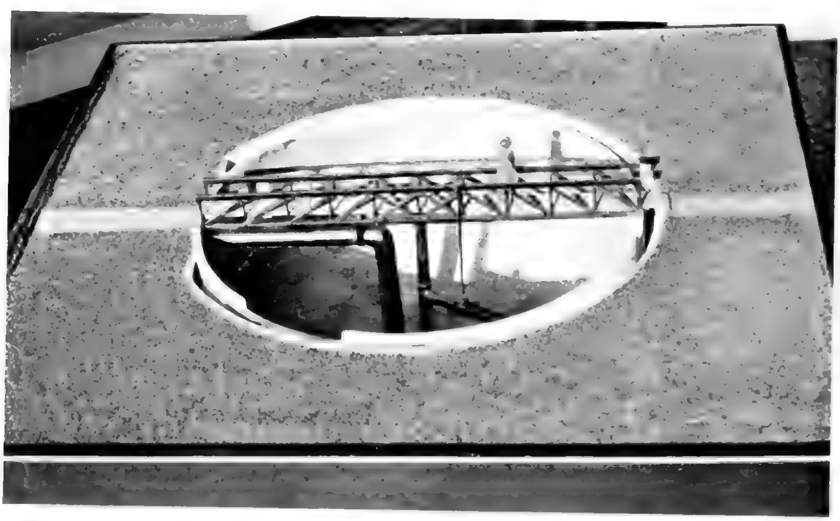
True sedimentation of organic solids requires a velocity as low as six feet per minute, or less maintained for a period of several hours; and the tanks used for such sedimentation are usually rectangular basins of concrete or masonry with a capacity of four to twelve hours flow of sewage. In place of shallow basins of this pattern English engineers, notably at the city of Birmingham, have obtained very satisfactory results by the use of deep tanks with conical or pyramidal bottoms. The sewage enters near the bottom and as it rises and spreads out in the conical section, progressively diminishes in velocity and leaves its suspended solid matter behind, so that the effluent flows off clear at the top. These deep tanks have the added advantage that the heavy sludge can be drawn off by a valve at the bottom

without emptying the liquid above. The ordinary shallow sedimentation basin will not remove more than from 50 to 65 per cent of the suspended solids, while the deep tanks at Birmingham effect a purification of 85 per cent.

Where still more complete removal of suspended solids seems to be called for, the force of gravity may be reënforced by the addition of chemicals which produce a flocculent precipitate, capable of carrying down with it the finer particles, even to some of those which exist in a state of colloidal suspension. This gives better purification but usually at a rather high cost.

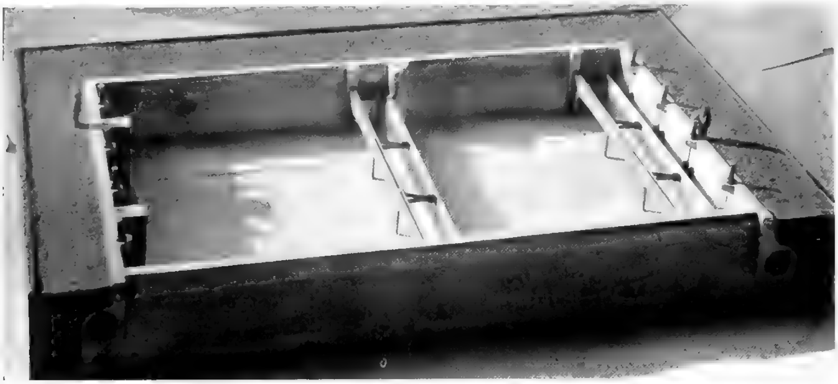
THE SLUDGE PROBLEM

In all processes of sedimentation a serious difficulty arises in connection with the disposal of the semi-solid sludge removed from the sewage and accumulated in the bottom of the basins. At the least there is produced some five to ten tons of wet sludge (containing 90 per cent of moisture) for every million gallons of sewage treated. For a community of one hundred persons (assuming 100 gallons of sewage per capita) this would mean one to two hundred pounds of wet sludge a day. With a village of one hundred persons it would be easy to deal with this semi-solid waste by burying it; but with a city of 100,000 inhabitants and 50 to 100 tons a



DEEP SEDIMENTATION TANK

A deep open tank for sedimentation of sewage. Photograph of a model in the American Museum



Septic tank or modified sedimentation basin. Photograph of a model in the American Museum

day to dispose of, the task is far from simple. As a matter of fact this is still a problem which awaits satisfactory solution. Cities on the seacoast can carry their sewage sludge out to sea in tank steamers and dump it in deep water with reasonable success and economy. For inland communities there remain only the alternatives of burying or burning, both of which are costly and unsatisfactory. Utilization seems theoretically promising, but it has not been practically realized except with sewages like that of Bradford, England, which contain an enormous proportion of fats from industrial sources.

THE SEPTIC TANK

There is one form of the process of sedimentation which is specially designed to minimize the sludge problem and which, to a limited extent, does achieve that end. This is the septic tank, associated particularly with the work of Cameron, but in its essential features dating far beyond the year 1895, when he gave it that picturesque name. The septic tank is indeed only a scientifically controlled and regulated cesspool, a sedimentation basin in which the suspended solids are removed by physical processes, but in which they are afterward allowed to remain so that they may be decomposed and reduced to the liquid form by the action of putrefactive bacteria.

The first septic tanks were tightly closed, in the opinion that this was essential to the desired liquefaction. It has since been found, however, that this is unnecessary. All that is essential is that the sewage, or the sludge removed from the sewage, should be retained in a stagnant condition;

the bacteria growing in the liquid consume oxygen much faster than it can be absorbed from the surface, and anaërobic conditions are easily maintained. In such a still pool of sewage sludge, the putrefactive bacteria effect a hydrolytic cleavage of the organic compounds and ultimately split them up into such simple forms as nitrogen, hydrogen, carbon dioxide and marsh gas.

Aside from certain minor details as to size and construction, the Cameron septic tank is simply a brick or masonry basin, covered perhaps with a wooden roof to protect it from the wind, but with no special features to distinguish it from any other tank. If in operation the sludge is removed at frequent intervals, the tank is merely a sedimentation basin. If the sludge is not removed putrefaction sets in, the liquid becomes dark colored, bubbles rise from the bottom and burst at the top and sometimes a thick crust or scum forms over the whole surface. The solids are changed first to liquid and then to gaseous form. The amount of gas evolved is large, four or five gallons from a hundred gallons of sewage, and with closed tanks it is possible to collect this gas and burn it.

The net practical result of the septic process is an appreciable reduction in the amount of stored suspended solids, due in part to the liquefying action of the bacteria and in part to consolidation of the sludge, which makes it more compact and easier to handle. The action of the tank falls far short, however, of the hopes entertained by its original promoters. Half or two-thirds of the sludge still remains to be handled, and the tank itself frequently becomes a nuisance from the evolution of odors of decomposition. Several improved types of liquefying tanks have been suggested during the last few years, of which the one designed by Imhoff for the Emscher Drainage Board of North Germany has in particular attracted wide attention. It is a tank with an upper portion through which the fresh sewage flows and a deep compartment below in which the sludge accumulates and liquefies, and it is said to effect a remarkable destruction of sludge with no obnoxious odors.

DISPOSAL OF SEWAGE BY DILUTION

The processes so far considered are preliminary processes only, which remove from the sewage a larger or smaller proportion of its burden of suspended solids but which do not attempt ultimate purification of the organic constituents, either in solution or suspension. The final aim of sewage purification is to effect a transformation of these organic compounds into innocuous mineral substances by the action of oxygen, and this action is nitrification, practically brought about by the action of certain bacteria.

When sewage is discharged in small volume into a relatively large body of water this process takes place spontaneously. The bacteria normally present in the water attack the organic matter and oxidize it and at the same time the typical sewage bacteria, finding themselves in an unfavorable environment gradually die and disappear. Disposal by dilution, or the discharge of sewage under regulated conditions into adequate bodies of water, is a recognized method of sewage purification, much used in Germany, and often with success. The discharge of too large volumes of sewage into bodies of water which could not successfully digest them has however frequently caused grave nuisances and dangers to health, and the undue concentration of sewage in small bays and in restricted areas near shore may produce local conditions of the same sort. Most inland cities and many seaport cities as well are therefore compelled to seek some special method of sewage treatment before their wastes can be discharged into adjacent water courses.

BROAD IRRIGATION OR SEWAGE FARMING

The most obvious alternative to the disposal of sewage in water is its distribution over the surface of suitable land; and this process of "broad irrigation" is the primitive form from which our modern modes of sewage treatment are derived. Under proper conditions the living earth readily absorbs and digests the foreign materials, by the same processes which lead to the annual disappearance of manure from heavily fertilized land; and the organic matter is not only rendered harmless but is changed into a form in which it serves as food material for the higher plants.

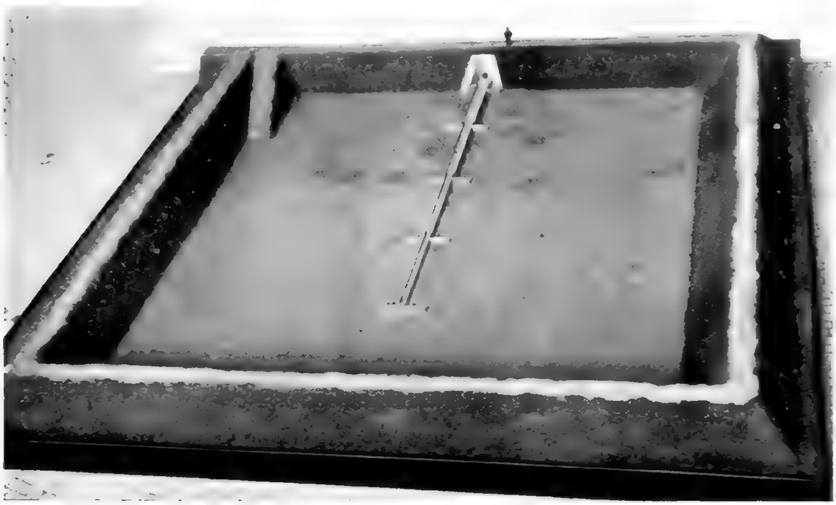
Baldwin Latham, the distinguished English engineer, believed that he had discovered sewers and irrigation areas in the ancient city of Jerusalem; and in China excreta have been utilized for centuries as fertilizer for the fields. At Lausanne in Switzerland, at Milan in Italy, at Bunzlau in Prussia, irrigation was practised in the fifteenth and sixteenth centuries. The extensive development of the art dated, however, from the wave of sanitary reform which swept over England as a result of the *Report of the Health of Towns Commission* in 1844. This report marked the beginning of extensive sewerage construction in the modern sense and with sewerage, sewage disposal was urgently required. With the desire to dispose of polluting material, there grew up in these early days a parallel interest in the possible profit to be derived from crops grown on the irrigated land. The two aims are well balanced in the definition of sewage farming as "the dis-

Courtesy of G. E. Bolling

INTERMITTENT SAND FILTERS, BROCKTON, MASSACHUSETTS

tribution of sewage over a large surface of ordinary agricultural land, having in view a maximum growth of vegetation (consistent with due purification)."

Progress in England along these lines was rapid, so that over two hundred irrigation areas of various sizes were in operation by 1883. Many are still in use to-day and on the continent, Paris and Berlin offer classic examples of this method of disposal. The Paris sewage is distributed on private land and it is not easy to form a sound judgment as to the success of the system. The Berlin farms on the other hand are operated by the city and offer an excellent example of sewage farming at its maximum of efficiency. The farms include 39,000 acres of excellent sandy soil, an area of over sixty square miles. Grass and cereals, potatoes and beets are cultivated and



Intermittent sand filter bed. Photograph of a model in the American Museum

dairies and distilleries are maintained for the utilization of the crops. Even the effluent drains are stocked with fish. The farms are operated by convict labor, and with German intelligence and German military discipline, the enterprise is not only successful as an experiment in sewage disposal but is also economically profitable, for the crops cover all costs of operation and pay for a part of the interest charges on the land.

In general, however, the results of broad irrigation have been by no means so favorable. The process requires large areas of land. The sewage of a community of one hundred persons would need from one to two acres; and the soil must be loose and sandy in character. Where, as in many English towns, the attempt is made to treat sewage on clayey soil, disaster

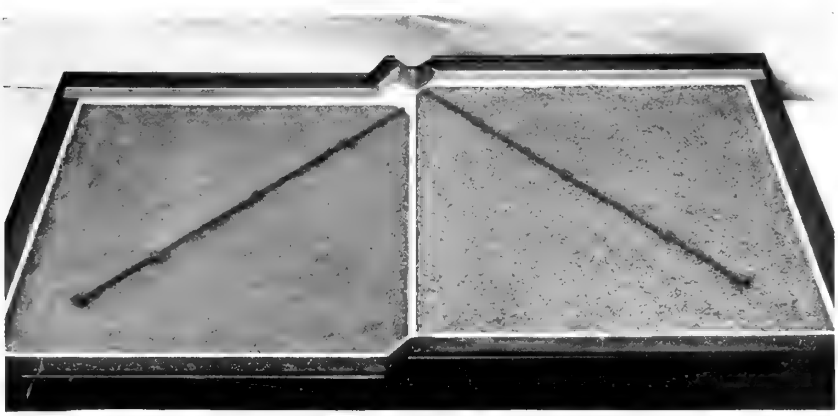
is almost sure to follow. The land clogs and becomes "sewage sick," a local nuisance is created and more or less unpurified sewage must be discharged into the nearest watercourse. Where local conditions and administrative efficiency are less favorable than at Berlin the economic advantage disappears. The most recent studies of the British Royal Commission indicate that cropping of irrigated land scarcely pays for itself — still less contributes toward the cost of sewage treatment. In the arid regions of the western part of the United States where every drop of water, as such, is precious and where the manurial value of sewage is reënforced by its water value, sewage farming becomes really profitable. In many parts of California and Colorado and other western states irrigation is clearly indicated as the best method of sewage treatment. Elsewhere, its application is more than problematical. The idea of converting the wastes of a city into walnut groves and fields of waving corn is an attractive one. The engineer, however, always wants to know the cost; and here, as in other modes of sewage utilization, it is poor policy to recover valuable elements that cost more to recover than their intrinsic value.

INTERMITTENT FILTRATION THROUGH SAND

The real art of sewage disposal began only when the crude process of broad irrigation was freed from the seductive hope of agricultural gain and developed intensively and scientifically as a means for sewage disposal pure and simple. Mainly through the experiments of the Massachusetts State Board of Health at Lawrence, it was shown that the essential process in sewage purification, either by dilution or broad irrigation, was an oxidation of organic compounds by the nitrifying bacteria, and that this process could be carried out much more efficiently by carefully controlling the conditions surrounding it. For a filter bed or substratum for the support of the growth of nitrifying bacteria, a fairly porous sand should be used, and the sewage should be applied in regulated intermittent doses with rests between for the supply of oxygen necessary to the process. By such means the rate of filtration can be raised from 5,000 to 10,000 gallons per acre per day (for broad irrigation) to 50,000 or 100,000 gallons. An intermittent filter of half an acre in area would therefore care for the sewage of five hundred persons while five acres of broad irrigation area would be needed for a similar population.

The construction of intermittent filters in regions like the northeastern part of the United States is extremely simple. This part of the country is

covered with deposits of glacial drift sand, ideal in character for sewage purification. All that is necessary is to expose and level off areas of this sand, to lay lines of underdrains a few feet below the surface to carry off the effluent, and to install devices for discharging the sewage on the surface. A bed may be dosed on one day out of three, or in smaller portions several times a day. In winter the beds are furrowed so that an ice roof forms on the top of the ridges while the sewage finds its way along the furrows between and, although less efficient in winter than in summer, the microbes do their work at all seasons well enough for practical purposes. The effluent from an intermittent filter, properly built and carefully operated, is a clear liquid, colorless or slightly yellowish in color, with no odor or only a slightly



Double contact beds for purification of sewage. Photograph of a model in the American Museum

musty one, practically free from putrescible organic matter and low in bacteria — a liquid that can be discharged with impunity into even the smallest watercourse.

The successful and economical use of the process of intermittent filtration is limited to those regions where ample areas of the right soil are easily available. In clayey or chalky regions, sand beds must be artificially constructed with material brought from a distance, and this would make the cost of the Massachusetts method almost prohibitive. In England where the sewage problem pressed hardest for solution, sand is usually not available and it was almost essential that further improvements should be made.

PANORAMIC VIEW OF TRICKLING FILTERS, COLUMBUS, OHIO

THE CONTACT BED

Mr. W. J. Dibdin, Chemist to the London County Council, was one of the first to attempt to modify the sewage filter so that it would operate at higher rates, and as a first step he naturally sought to build his beds of coarser material. In a notable series of experiments at the Barking outfall on the Thames, he found that the nitrifying bacteria could be grown on fragments of coke or stone as well as on sand and that purification could be effected in such beds if only the sewage were held in contact with the material, instead of being allowed to stream directly through. In sand filters, frictional resistance delays the passage of the sewage, so that time is given for the purifying process. With coarser materials, however, it is necessary to regulate the flow by making the beds water-tight and retaining the sewage in them until purification is completed. This was in outline the genesis of the contact bed.

Beds of this type are simply concrete or masonry basins, filled with crushed stone or coke or slag, in which sewage is allowed to stand for a period of about two hours. After one dose is withdrawn the bed stands empty for aëration for four hours or so and another dose is then introduced, three fillings a day being perhaps an average. A single contact treatment does not commonly yield an effluent sufficiently stable to discharge into a small stream. It is the general practise therefore to use double contact, treating the sewage first in a bed of coarse stone, perhaps one and one-half to two

inches in diameter, and then in a fine bed, of perhaps half-inch material. The rate of treatment, even so however, is much higher than that commonly used with sand beds, 500,000 gallons per acre per day against 100,000. Half an acre of contact beds would treat the sewage from a population of 2,500 against 500 for the intermittent filter. The effluent even from double contact is less highly purified than an intermittent filter effluent. It is dark and somewhat turbid, but it should be free from the tendency to putrefactive decomposition.

THE TRICKLING FILTER

Meanwhile the problem of purifying sewage at high rates was being attacked in another and even more promising manner. The fundamental combination of bacterial films, sewage and air can be effected in various ways. The late Colonel George E. Waring attempted it at Newport in 1894 by blowing air into a bed of coarse stone below, while sewage ran down through it from above. Theoretically this seems a satisfactory process but it has not yet been demonstrated that a sufficient supply of oxygen can be economically provided in this manner. Success was finally reached along another line by resorting to the device of applying sewage, not in bulk, but in a fine spray distributed as evenly as possible over the surface of the bed. By this means the rapid flow of large streams of sewage is prevented and the liquid trickles in thin films over the surfaces of the filling material while the spaces between are continually filled with air, the oxygen content

of which in practise does not become seriously exhausted. The condition is analogous to that which obtains in the process of vinegar manufacture when alcoholic liquor is allowed to run over shavings covered with growths of acetic acid bacteria. Under the name of the trickling bed (called also sprinkling bed or percolating bed) this has come to be considered one of the most promising and effective of all devices for sewage purification.

As in the case of contact beds, almost any hard non-friable material may be used for the construction of trickling filters. In America the size of the filling material is generally between one and four inches and the depth of the beds between five and eight feet. Mr. Rudolph Hering in a very enlightening review of the underlying principles of sewage treatment has recently pointed out that there are three fundamental variables in this process of purification, air supply, total area of bacterial films and time of exposure. The area of bacterial films is conditioned by the size of the filling material and the depth of the bed (the smallest material, of course, giving the greatest surface) and the time of exposure is controlled by the rate at which sewage is applied. Reduced to its lowest terms a trickling filter is simply a heap of stone or other material of such size, depth and texture as to support a bacterial growth sufficient for the work in hand.

The distribution of the sewage over the surface constitutes the most serious difficulty in the construction and operation of the trickling bed. In England, many of the disposal areas are equipped with mechanical distributors of great complexity. Some are designed on the principle of the lawn sprinkler and are revolved by the propulsive force of the sewage as it is discharged. Others are in the form of great movable weirs which pass back and forth on rectangular beds, dripping sewage as they go. At Hanley a mechanical distributor was installed for a quarter acre bed which weighed twelve tons and wore out a forty-five pound bridge rail in two and a half years.

At other English plants, like the most famous of all at Birmingham, and at most American disposal areas, the sewage is distributed by spraying it upward from fixed sprinkler nozzles. This method effects a less perfect distribution than that attained by the English mechanical apparatus but the cost of construction and renewal is much less.

The trickling filter can be operated at a rate of 2,000,000 gallons per acre per day, or four times as fast as the contact bed. Half an acre of trickling beds would care for the sewage from 10,000 persons while a similar area would only do for 2500 persons with the contact bed and for 500 with the intermittent filter. Furthermore trickling beds are practically free from the clogging which menaces the permanency of the contact process.

for the suspended matter comes through trickling beds in the long run in about the same amount in which it goes on at the top, changed only in its chemical nature. The effluent is far less well purified than that of a sand filter. It is more turbid even than contact effluent and in appearance may not even seem very different from untreated sewage; however, the essential changes have been brought about. The more unstable organic bodies have been oxidized and the effluent contains a sufficient excess of oxygen so that succeeding changes will be nitrifications and not putrefactions. At Birmingham, England, where the trickling process has been most ably and exhaustively studied, a sewage flow of 30 million gallons a day is treated first in sedimentation and septic tanks and then on trickling beds, having a total area of about thirty acres; and in dismissing an injunction granted against the city by a lower court the Master of the Rolls has recently decided that the effluent from the Birmingham works actually improves the character of the river into which it is discharged. The large plants recently constructed in the United States at Columbus, Ohio (twenty million gallons), at Washington, Pa. (one million gallons), at Reading, Pa. (two million gallons) and at Mt. Vernon, N. Y. (three million gallons) are all of the trickling type. The trickling filter is indeed an ideal mechanism for solving the essential problem of sewage disposal. It exhibits the simplicity of all scientific applications, which are merely intelligent intensifications of natural processes. A pile of stones on which bacterial growth may gather and a regulated supply of air and sewage are the only desiderata. We meet the conditions resulting from an abnormal aggregation of human life in the city by setting up a second city of microbes. The dangerous organic waste material produced in the city of human habitations is carried out to the city of microbes on their hills of rocks, and we rely on them to turn it over into a harmless mineral form.

SEWAGE DISINFECTION

So far nothing has been said about the problem of bacterial removal. In general this is a subsidiary question in sewage purification. Frequently the elimination of offensive organic decomposition is all that is necessary and bacteria can be allowed to pass with the effluent into the stream, to be removed by the quite distinct processes of water purification from any water taken out for human consumption. Sand filtration effects a very considerable purification in living and lifeless constituents alike; but the

SEPTIC TANKS, COLUMBUS, OHIO

Twenty million gallons of sewage a day can be treated in this recently constructed plant

contact and trickling beds are essentially oxidizing mechanisms without filtering action adequate for the removal of micro-organisms. It is true that in the unfavorable environment of the septic tank and trickling filter, many sewage organisms do die out, but their elimination is incomplete and uncertain. If a nearly germ-free effluent is required some special method must be adopted for bacterial removal. This particular problem has come into great importance of late in connection with the protection of shellfish industries, menaced by the sewage of seaboard cities. Fortunately there has been worked out to meet this need a simple and efficient method, a new chemical treatment, not designed as in the old precipitation processes to remove suspended solids but merely to destroy living germs. The application of ordinary bleaching powder, or chloride of lime, in small amounts of fifteen to thirty parts of bleaching powder to a million parts of sewage will effect a satisfactory reduction of bacteria at a very reasonable cost, as shown first by Mr. S. Rideal in England and by Prof. E. B. Phelps in this country. Baltimore, Maryland, has adopted this procedure as have certain small towns on the New Jersey coast; and it promises to be of use in dealing with certain phases of the New York Harbor problems.

There are many questions still to be solved in the purification of sewage. The removal of suspended matter, for example, urgently demands further careful study; yet the work of the last ten years in England and the United States has blocked out the main outlines of satisfactory sewage disposal practice. The engineer can to-day successfully meet any demand for the purification of domestic sewage; and this purification may be carried to any degree of perfection for which the community in question is prepared to pay. If a clear and sparkling effluent, highly purified bacterially, is desired he can design an intermittent filter for that purpose. If merely a stable effluent which may be discharged into a stream without creating a nuisance is wanted, he can build a trickling filter. If, on the other hand, a disinfected but not organically purified effluent is called for, that end, too, may be attained.

INDEX

Page numbers of illustrations are indicated by heavy face type

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY

For Sale at the Museum

(Issued as supplements to The American Museum Journal)

No. 1.— THE BIRD ROCK GROUP. By F. M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price, 10 cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. SMITH, Assistant Curator of Archæology. December, 1901. *Price, 10 cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By LOUIS P. GRATACAP, A. M., Curator of Mineralogy. February, 1902. *Revised Edition*, May, 1904. *Price, 10 cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. ALLEN, Ph.D. Curator of Mammalogy and Ornithology. March, 1902. *Revised edition*, February, 1904. *Price, 10 cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By GEORGE H. PEPPER, Assistant in Anthropology. April, 1902. *Second edition*, May, 1909. *Price, 10 cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. May, 1902. *Out of print.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By GEORGE H. SHERWOOD, A. M., Assistant Curator. November, 1902. *Price, 10 cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition*, May, 1905. *Out of print.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. February, 1903. *Price, 10 cents.*

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price, 10 cents.*

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. October, 1903. *Out of Print.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRDS' NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted*, February, 1905. *Price, 10 cents.*

No. 15.— PRIMITIVE ART. July, 1904. *Price, 15 cents.*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Price, 15 cents.*

(Reprinted from The American Museum Journal)

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1905. *Out of print.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Out of print.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price, 15 cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Price, 10 cents.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price, 15 cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Out of print.*

(Published as a separate series)

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price, 10 cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Out of print.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price, 10 cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Price, 15 cents.*

No. 28.— THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price, 15 cents.*

No. 29.— THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909. *Price, 10 cents.*

No. 30.— THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO. November, 1909. *Price, 5 cents.*

No. 31.— BRIEF HISTORY OF ANTARCTIC EXPLORATION. March, 1910. *Price, 10 cents.*

No. 32.— TREES AND FORESTRY. By MARY CYNTHIA DICKERSON, B. S., Curator of Woods and Forestry. September, 1910. *Price, 25 cents.*

No. 33.— THE PROTECTION OF RIVER AND HARBOR WATERS FROM MUNICIPAL WASTES. By CHARLES-EDWARD AMORY WINSLOW, Curator of Public Health. April, 1911. *Price, 10 cents.*

AMERICAN MUSEUM OF NATURAL HISTORY

Plant Forms in Wax

WAX MODEL OF FLOWERING DOGWOOD, FORESTRY HALL

Department of Preparation and Installation

GUIDE LEAFLET NO. 34

NOVEMBER, 1911

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

THE MUSEUM IS OPEN FREE TO THE PUBLIC ON EVERY DAY IN THE YEAR.

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world. The membership fees are,

Annual Members	$ 10	Fellows	$ 500
Sustaining Members (Annual)	25	Patrons	1000
Life Members	100	Benefactors (Gift or bequest)	50,000

THE MUSEUM LIBRARY contains more than 60,000 volumes with a good working collection of publications issued by scientific institutions and societies in this country and abroad. The library is open to the public for reference daily — Sundays and holidays excepted — from 9 A. M. to 5 P. M.

THE MUSEUM PUBLICATIONS are issued in six series: The American Museum Journal, Annual Report, Anthropological Papers, Bulletins, Guide Leaflets and Memoirs. Information concerning their sale may be obtained at the Museum Library.

GUIDES FOR STUDY OF EXHIBITS are provided on request by the Department of Public Education. Teachers wishing to bring classes should write or telephone the Department for an appointment, specifying the collection to be studied. Lectures to classes may also be arranged for. In all cases the best results are obtained with small groups of children.

WORKROOMS AND STORAGE COLLECTIONS may be visited by persons presenting membership tickets. The storage collections are open to all persons desiring to examine specimens for special study. Applications should be made at the information desk.

THE MITLA RESTAURANT in the east basement is reached by the elevator and is open from 12 to 5 on all days except Sundays. Afternoon Tea is served from 2 to 5. The Mitla Room is of unusual interest as an exhibition hall being an exact reproduction of temple ruins at Mitla, Mexico.

Making Wax Leaves

The method of making leaves described in this Leaflet, depending on the use of Mousselaine de Soie, the mysterious "fabric" of the Mogridges, has been largely superseded by the use of cotton batting. The advantages of cotton batting are that the leaf is homogeneous in composition and is less liable to curl or split, and that the stem wire is more securely imbedded in and attached to the substance of the leaf. The material is also more readily obtained, especially in small places. The finer the quality the better, but it is not necessary to use the finest and softest for large leaves.

A thin layer of cotton is spread over the lower half of the mold, the stem laid on this and, if the leaf is thick, a very little cotton laid on the stem; melted wax is then poured over this and the upper part of the mold pressed upon the mass.

The use of molds hardened in paraffin, as noted on page 12, is attended with some difficulty, as wax has a tendency to adhere to them; a simpler method of hardening molds is to boil them for from ten to twenty minutes, according to size, in a strong solution of borax.

If a mold is to be used a great many times a good plan is to place it in hot linseed oil for about 5 minutes and let it dry for a week or ten days before using.

Finally where large numbers of leaves of a kind are to be made, the molds are often made in type metal or bronze and these are fastened to wood or metal frames, hinged together at one end on the principle of an old-fashioned lemon-squeezer. The lower arm may be fastened to a table, and, in the case of large leaves, it frequently happens that two persons may work together to good advantage, one spreading the cotton and pouring the wax, the other doing the squeezing and removing the leaf from the mold. In the case of large parti-colored leaves, for example, green and white or green and red, two colors of wax may sometimes be used to advantage.

AUGUST BIRD LIFE OF THE HACKENSACK MEADOWS

A Habitat Bird Group showing much accessory work in wax-grasses, arrowhead and cat-tails, marsh mallows and jewelweed

A CACTUS DESERT AND ITS BIRD LIFE

In reproducing a cactus the spines must be removed and replaced in their proper position on the wax cast

AT THE EDGE OF THE JUNGLE

Orchid, ferns and vines of India reproduced in wax to show haunt of water monitor and cobra

WAX REPRODUCTION OF CATALPA FLOWERS AND LEAVES

Many of the models in the Forestry Hall are so accurately copied from life that observers, sometimes even botanists, judge them natural instead of artificial and send questions to the Museum concerning methods of preservation

THE BULLFROG GROUP

Birch, alder and willow, pickerel weed, swamp azalea and white water lilies give an unusual effect of realism notwithstanding that all are reproductions in wax

PLANT FORMS IN WAX

SOME METHODS EMPLOYED

IN THE

Department of Preparation and Installation

OF THE

American Museum of Natural History

By E. C. B. FASSETT

NEW YORK
Published by the Museum
November, 1911

NO. 34

OF THE

GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

MARY CYNTHIA DICKERSON, Editor

A SMALL PORTION OF THE BULLFROG GROUP SHOWING PICKEREL WEED

PLANT FORMS IN WAX

SOME METHODS EMPLOYED IN THE DEPARTMENT OF PREPARATION AND INSTALLATION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

By E. C. B. Fassett

Introduction

THE preparation of exhibits is a primary function of a museum and public appreciation of such an institution is largely dependent upon the excellence attained in this preparation. Moreover, the attractiveness and instructive force of an exhibit often depend almost as much upon the accessories employed in connection with the objects as upon the objects themselves. Thus, a group of birds, of mammals, or of insects must often be arranged to show relation to natural surroundings, therefore requiring foliage which must be reproduced by artificial means since plants in drying do not retain their strength or their lifelike appearance.

The work of the taxidermist in a museum is supplemented nowadays by that of the wax modeler, the glass blower and the plaster worker. Several handicrafts, indeed, contribute to the finished exhibit, including those of the photographer, painter and clay modeler. All these handicrafts have community interests and one is the supplement of the others in the attainment of desired results.

The composition of a group to be assembled must be built on photographic realism in a science museum where accuracy is one of the large

MODEL OF FLOWERING DOGWOOD IN THE FORESTRY HALL

aims. A bird group, for instance, with its painted canvas background and real foreground must be based not only upon actual photographs but on field notes as well, made by an artist colorist. Plants, sections of shrubs, flowers and every significant detail of the immediate habitat, such as sticks, stones, earth, grass and dead leaves, are collected for the realistic foreground. A landscape painter makes the background and the craftsmen strive to blend the foreground with this background and thus bring the entire group into lifelike harmony.

After color notes and photographs have been made of the plants necessary for a certain group, plaster molds are made of the leaves and flowers. These molds are best prepared from fresh specimens, but are obtainable also from specimens preserved in formaldehyde.

The methods which have been worked out in the Department of Preparation of the American Museum all strive for artistic realism of detail, and while the spectator's interest centers in the birds or other natural history specimens for whose proper exhibition the group has been assembled, the accessories also claim appreciative notice. The successful reproduction in wax of the various plant forms is accomplished by persistent experiment, for each new object is in some degree an individual problem. Some of the methods employed, and in many cases evolved by the wax workers in the progress of their work, are explained by the accompanying series of photographs which even without the explanatory notes would give a comprehensive idea of many of the processes.

WHITE AZALEA AND BIRCH OF THE BULLFROG GROUP

LEAF-MAKING

An apprentice wax worker is first taught leaf-making, the simplest part of the work. Photographs from the growing plant are made in the field for later guidance. Then in the laboratory of the Museum, after the branches which are to be used

Plaster Molds

are selected, plaster molds are made of a series of leaves to secure a variety of sizes. The molds, after being thoroughly dried and immersed twenty minutes in hot paraffin, are ready for use.

The simplest mold is the one-piece mold used in the reproduction of many leaves and flower petals. The leaf or petal is laid face upper-

MAKING A MOLD OF A LEAF

A thick heavy leaf (7 in. x 8 in.) pressed into a clay bed ready for the pouring of the plaster over it to make the mold

most on a surface of clay, the clay bedded up beneath and around to support the leaf in its natural position and plaster of Paris mixed and poured over it. When the plaster has set, the leaf is removed and the superfluous plaster trimmed away around the impression.

PLASTER MOLD OF A LARGE TROPICAL LEAF

The completed reproduction measuring twenty inches in diameter rests on an ordinary chair

Squeeze molds and piece molds, the former usually of two pieces, the latter of two or more pieces, are made in much the same way although they differ in use. The upper of the two pieces of the squeeze mold

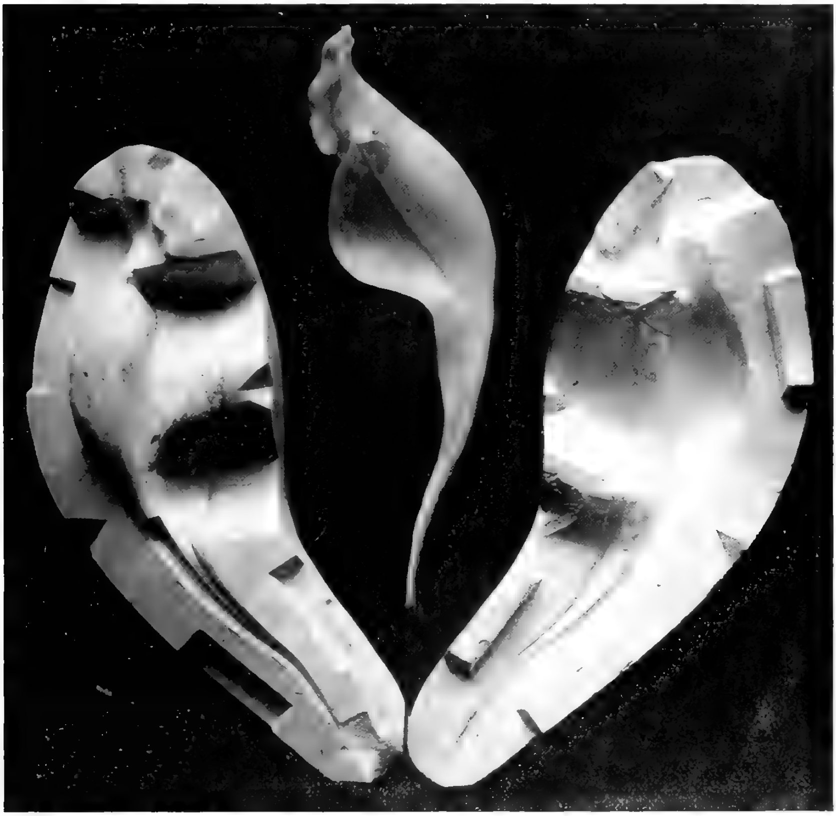
COMPLETED WAX REPRODUCTION OF LEAF

Tropical leaf (13 in. x 18 in.) which has been laid back into the plaster mold to restore modeling of the surface which may have been lost in the trimming process. The supporting wires are very conspicuous on the back but appear only as a part of the venation on the face of the leaf

fits into the lower which is usually concave or cup-shaped. The wax is poured into the lower mold and the upper is forced down into it to squeeze out the excess of wax. The two or more pieces of the piece

mold when held together form a receptacle into which wax is poured through a funnel-like "gate" cut in the plaster.

The materials used for the reproduction of the leaf are sheet wax,

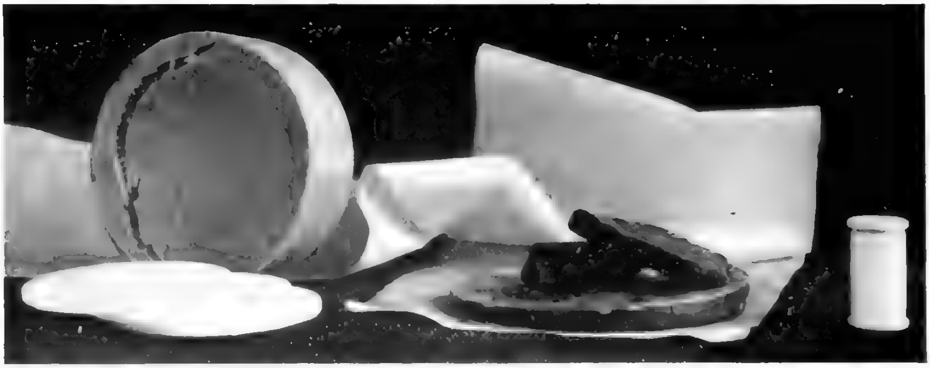


A COMPLETED WAX LEAF OF SARRACENIA, OR PITCHER PLANT, AND A PAIR OF THE SQUEEZE MOLDS USED IN MAKING ONE HALF OF IT

There must be a duplicate pair of squeeze molds, minus the keeled part, for the other half of the leaf. The two sections of the wax leaf are welded with a hot tool. Much of the beauty and delicacy of this result depends on the trimming and beveling of the edges of the wax and the artistic feeling displayed by the craftsman

The Materials for the Leaf

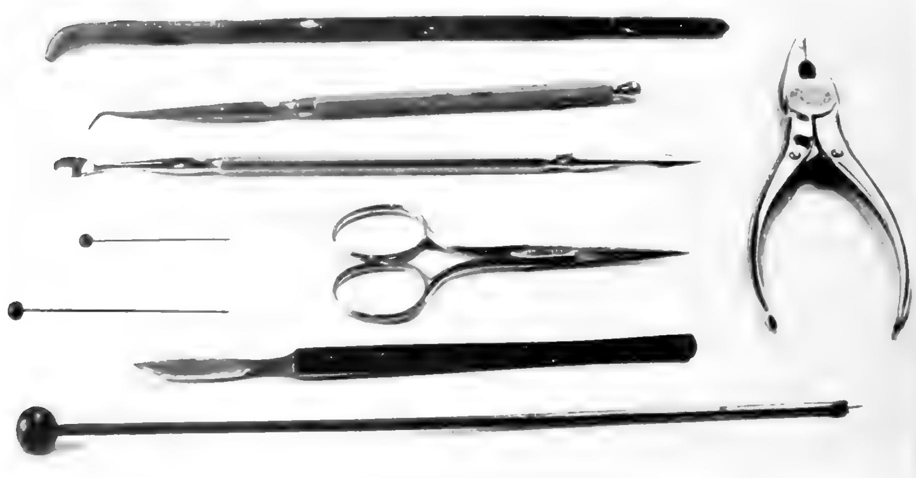
waxed gauze and wire, the sheet wax forming the face of the leaf, the waxed gauze the back and the wire the ribs. The wax should be pure bleached beeswax with a small amount of Canada balsam, that is, about one tablespoonful for each



SOME MATERIALS USED IN MAKING WAX LEAVES AND FLOWERS

Three discs of bleached beeswax; two pieces of wax which have been prepared for use by tinting and by the addition of Canada balsam to give pliability; a piece of waxed gauze and a spool of wire

quart of the melted wax. The wax should be heated in a double boiler. Waxed gauze is prepared by dipping strips of bolting cloth or mousseline de soie into hot wax and withdrawing vertically over a glass rod with



SOME TOOLS USED IN WORK WITH WAX

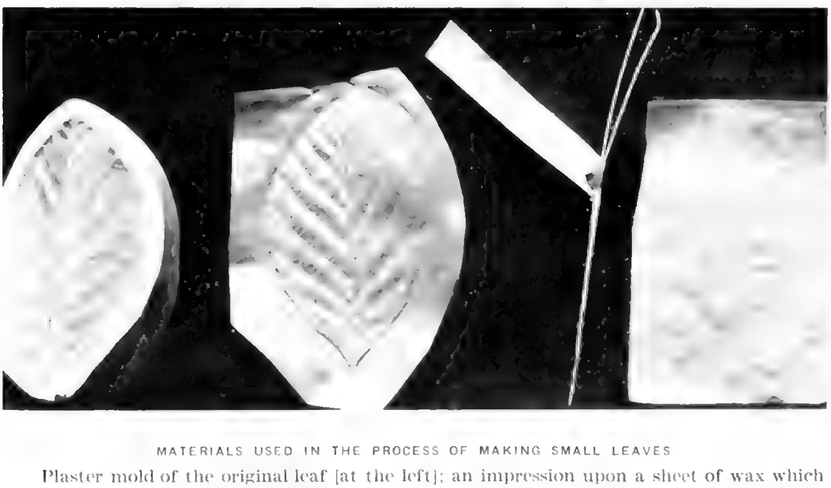
Hat pins and smaller pins with glass heads used for modeling edges of leaves and petals as well as for many other purposes; a sharp knife for beveling edges of leaves and petals; small scissors for serrating leaf margins; a wire cutter; a spoon-like tool which may be heated to melt and hold a few drops of wax for welding; a general utility tool where heat is needed; a larger agate tool which supplements the fingers in welding the waxed gauze into deep ridges

FLOWERS AND FRUITS OF THE PAPAW

Many of the wax models in the Forestry Hall reproduce the texture of flowers and fruits in a remarkable way

THE OPERATION OF WAXING THE GAUZE

Wax is brought to a boiling point in a double boiler, tinted the desired shade and a small quantity of Canada balsam added. A strip of gauze (mousseline de soie) is submerged in the boiling wax and then drawn out vertically across a glass rod, with greater or less speed as a thin or thick coating of the wax is desired. A still thicker waxing is obtained by omitting the use of the glass rod and blowing upon the gauze as it is withdrawn



MATERIALS USED IN THE PROCESS OF MAKING SMALL LEAVES

Plaster mold of the original leaf [at the left]; an impression upon a sheet of wax which was laid over the wet plaster mold and worked with the warm fingers into every detail of the mold; the wire midrib partly wrapped with waxed gauze; piece of waxed gauze which must be welded to the wax after the adjustment of the midrib

Two pieces of wire are used for the midrib, one extending a short distance beyond the other for the sake of delicacy. All the work on the leaf until ready for trimming or serrating the edges is done while it lies on the plaster mold

greater or less speed as a thin or thick coating is desired. Still greater thickness of the wax is obtained by omitting the use of this rod, simply dipping the strips of cloth and letting them drip while blowing on the hot wax.

Tinting the Wax

The wax is tinted by mixing small quantities of oil color in a ladle of fluid wax which is afterward gradually added to the heated mass until the desired shade is obtained.

The Wire Foundation

Silk-wound wire, which should vary in thickness according to the size and weight of the leaf, is taken from the spool and stretched until it no longer curls; then it is cut into suitable lengths for the midribs. Heavy wire and additional supporting ribs are used for the largest leaves and are covered with strips of waxed gauze to bring about more complete adhesion with the wax of the leaf. A sufficient quantity of wires, sheet wax and waxed gauze is prepared in advance for the work planned.

The Order of Work

A piece of this sheet wax is warmed over the flame of the spirit lamp or Bunsen burner and applied to the plaster mold, the surface of which has been previously dampened with cold water to prevent adhesion of the wax. The wax is molded with the finger tips until there appears on the wax a good impression of the pattern of the plaster mold underneath. The wire for the midrib is then laid in its proper position upon the wax and covered with a sheet of waxed gauze. The task of welding this gauze to the wax requires care and patience as all air-bubbles must be worked out and the details of venation sharply defined.

PRESSING THE SHEET WAX INTO THE PLASTER MOLD

After placing the wire for the midrib in position, the waxed gauze is welded to the wax. For deeply veined or ridged leaves a rubber tool facilitates the work

THE ADJUSTMENT OF THE WIRE SKELETON TO A WAX LEAF

Before removing the leaf from the mold, the marginal outline is indicated and welded either with the finger nail or some pointed instrument.

The Leaf Margin

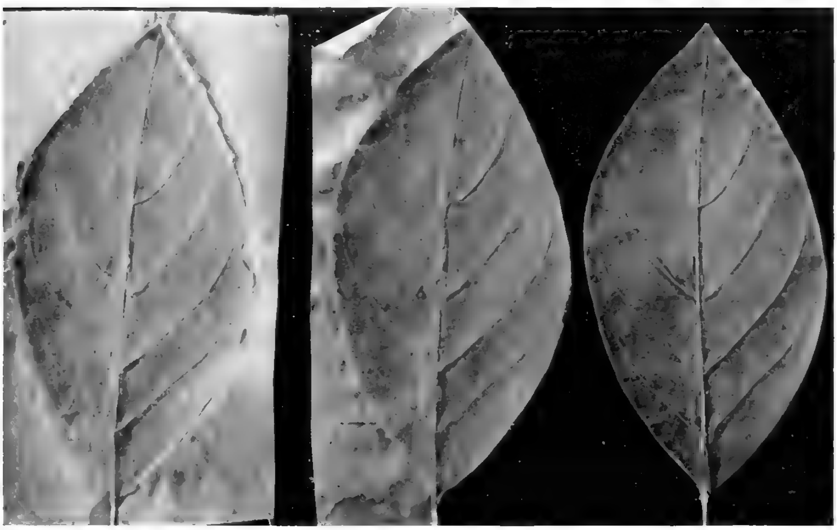
The serration of the margins of the leaves calls for deftness and considerable practice. Slightly heat small sharp scissors; then, beginning the cutting at the lower right side of the leaf, let forward, sliding strokes of the scissors alternate

TRIMMING THE MARGIN AFTER THE WAXED GAUZE HAS BEEN FIRMLY WELDED
The position is the same as in the process of serrating the leaf edge

with short horizontal strokes until the tip of the leaf is reached. Then reverse the leaf and cut the left side by a descending process which also reverses the motions used on the opposite edge. After the serration, the leaf is again carefully applied to the mold, the serrated edges are re-welded and the contour of the leaf perfected.

Attachment to the Twig

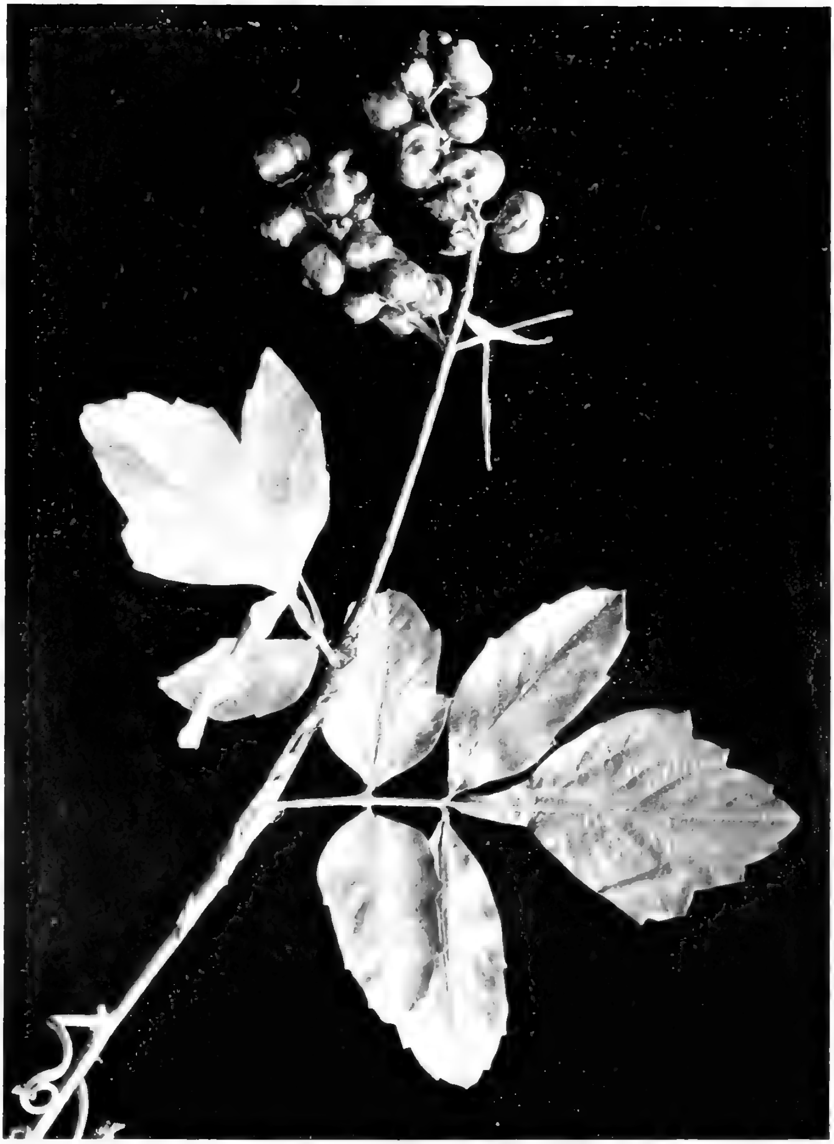
After the colorist has tinted the leaves either by hand or with the aid of an air-brush, they are ready for attachment to stems. Small stems are made of silk-wound wires wrapped with waxed gauze; they are tinted and then attached to the



THREE PHASES IN THE PROCESS OF CUTTING OUT A LARGE LEAF

In each figure there is presented the back of the wax leaf (6 in. x 3 in.). The leaf was made by the flowing process and has the wire skeleton adjusted and the waxed gauze welded

original wood. In the case of larger stems the original woody branch is used having first been subjected to treatment with glycerine and formaldehyde, which preserves the original bulk of the woody fibre. In attaching each leaf, a hole is drilled at the point of juncture and the wire stem of the leaf passed through and secured. All evidences of the attachment are carefully obliterated by wax and color.



ILLUSTRATING METHOD OF ATTACHING WAX FRUIT AND LEAVES TO THE ORIGINAL BRANCH

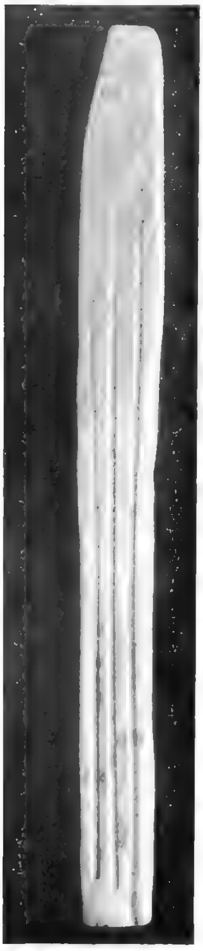
The berries are cast in piece molds, then modeled in more detail by hand. The wire stems are inserted in holes made with a hot tool and the berries are grouped on a wire stem. This stem is wrapped with waxed gauze and covered with a flow of wax. A portion of this heavier wire is left uncovered and inserted into a hole bored in the natural stem or branch. After the wire is secured it is wrapped with waxed gauze, covered with modeled wax and tinted, making a juncture as much like nature as possible

POURING THE HOT WAX OVER A PLASTER MOLD

Flowing Process or Leaf Casting

In making large leaves like hellebore, pickerel weed and many tropical leaves, sheet wax is not used; instead hot wax is poured directly over the mold which has been previously placed in hot water to expel air from the plaster. This flowing process greatly facilitates the work. In the reproduction of a large leaf many wires must be used to serve not only as midribs but as additional supports for the heavy mass of wax. The wire of the

midrib is attached to a heavier wire and wrapped throughout its length with waxed gauze until the proper size is attained. The welding of the waxed gauze must be done with care, the agate tool supplementing the use of the fingers. Finally the leaf is ready for the colorist.



Cactus, Cat-tail, Grass

Cactus may be cast in piece molds and the original spines inserted in the wax. Bladelike leaves of cat-tails may be made from molds. A thin layer of hot wax is flowed into the mold and into this a strip of waxed gauze is pressed. A midrib of fine steel wire wrapped with waxed gauze, is carefully adjusted and over this a second flow of hot wax is poured, and over the wax again a second piece of waxed gauze is welded by passing a hot tool over the surface. Blades of grass are cut from heavily waxed gauze and are modeled by folding them laterally over the edge of a knifelike strip of tin fixed in a wooden base. Very little manipulation is required. No rib is used, but each blade from a short distance above the base is rolled about a wire and several blades are then attached to a heavier wire stem.

FLOWER-MAKING

Flowers Made with a Die

Flowers are more difficult to reproduce in wax than are leaves because more complex and may be made by various methods. More often they are cut out from waxed gauze with a die, or perhaps with scissors according to a pattern. A die is usually made for simple monopetalous flowers such as pickerel weed, the tube being cut lengthwise and the corolla

PLASTER MOLD FOR MAKING THE BLADES OF THE CAT-TAIL

The three indentations in this mold were made by pouring soft plaster over the fresh green plant. Hot wax is poured into the mold in a thin layer and a sheet of waxed gauze welded into it. Fine steel wires, one extending beyond the other for the tip of the leaf, are wrapped with a strip of waxed gauze and adjusted along the middle line. Over the wire there is a second flow of wax and over the wax a second strip of waxed gauze which again is covered with a flow of wax. A hot tool is then run over the surface and a perfect welding made

DIE, MALLET AND WAXED GAUZE FROM WHICH SEPALS HAVE BEEN CUT

The waxed gauze is laid on a wet block and the die is also dipped into water to prevent adhesion of the wax. A sharp blow from the mallet forces the die through the gauze with a clean-cut edge. A die is used when many small parts like sepals or delicate petals are required

spread out to make the pattern for the die. Such corollas can be cut with one blow of the mallet on the die. Then with a hot tool the tube is welded together, while the petals are curled and adjusted according to life position.

Squeeze Molds for Flowers

For monopetalous corollas of more complex contours such as catalpa, squeeze molds are used, each consisting of two parts the upper fitting into the lower. In this process hot wax is poured over the lower half of the mold and a piece of gauze is pressed into the wax with an agate tool. A second flow of wax is poured over it, and the obverse or upper half of the mold is pressed down squeezing out all superfluous wax. The whole is then thrown into cold water until the wax is hard, when the cast is removed from the mold with the assistance of a glass rod. The impressed wax is trimmed, the rim edges beveled and the edges of the corolla tube welded by means of a hot tool. In still more complex flowers, as some orchids, it is necessary to subdivide and make molds for each half. The welding of the two halves requires skill. The foliage of the pitcher plant also is made in this manner.

Pistils and Stamens

The stemlike parts of pistils and stamens are reproduced from thread which has been drawn through boiling wax under the pressure of a brush. Sometimes fine wires are used in the same way. Stigmas and anthers are made of colored wax applied with a hot tool to the tips of these stemlike parts.

Piece Molds for Thick Buds and for Fruits

Objects of considerable thickness such as buds of water lilies and magnolias, or buds of any large fleshy flower must be cast in piece molds, as also are berries and fruits. There is necessarily some trimming of the tips and stem ends in the making of these forms. A hot wire is thrust into the stem end of the bud or the fruit which is thus fastened to the branch.

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY

For Sale at the Museum

No. 1.— THE BIRD ROCK GROUP. By F. M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price, 10 cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. SMITH, Assistant Curator of Archæology. December, 1901. *Price, 10 cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By LOUIS P. GRATACAP, A. M., Curator of Mineralogy. February, 1902. *Revised edition*, May, 1904. *Price, 10 cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. ALLEN, Ph.D. Curator of Mammalogy and Ornithology. March, 1902. *Revised edition*, February, 1904. *Price, 10 cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By GEORGE H. PEPPER, Assistant in Anthropology. April, 1902. *Second edition*, May, 1909. *Price, 10 cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. May, 1902. *Out of print.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By GEORGE H. SHERWOOD, A. M., Assistant Curator. November, 1902. *Price, 10 cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition*, May, 1905. *Out of print.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. February, 1903. *Price, 10 cents.*

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price, 10 cents.*

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. October, 1903. *Out of Print.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRDS' NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted*, February, 1905. *Out of print.*

No. 15 — PRIMITIVE ART. July, 1904. *Price, 15 cents*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Out of print.*

No. 17 — THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1905. *Out of print.*

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Out of print.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price.* 15 *cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN D. M. D. January, 1906. *Out of print.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price,* 15 *cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Out of print.*

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price,* 10 *cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Out of print.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price,* 10 *cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Out of print.*

No. 28.— THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price,* 15 *cents.*

No. 29.— THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909. *Price,* 10 *cents.*

No. 30.— THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO. November, 1909. *Price,* 5 *cents.*

No. 31 — BRIEF HISTORY OF ANTARCTIC EXPLORATION. March, 1910. *Price,* 10 *cents.*

No. 32.— TREES AND FORESTRY. By MARY CYNTHIA DICKERSON, B. S., Curator of Woods and Forestry. September, 1910. *Price,* 15 *cents.*

No. 33.— THE PROTECTION OF RIVER AND HARBOR WATERS FROM MUNICIPAL WASTES. BY CHARLES-EDWARD AMORY WINSLOW, Curator of Public Health. April, 1911. *Price,* 10 *cents.*

No. 34.— PLANT FORMS IN WAX. By E. C. B. FASSETT. November, 1911. *Price,* 10 *cents*

Scientific Staff

DIRECTOR
Frederic A. Lucas, Sc.D.

GEOLOGY AND INVERTEBRATE PALÆONTOLOGY
Edmund Otis Hovey, A.B., Ph.D., Curator

MINERALOGY
L. P. Gratacap, Ph.B., A.B., A.M., Curator
George F. Kunz, A.M., Ph.D., Honorary Curator of Gems

INVERTEBRATE ZOÖLOGY
Prof. Henry E. Crampton, A.B., Ph.D., Curator
Roy W. Miner, A.B., Assistant Curator
Frank E. Lutz, A.B., A.M., Ph.D., Assistant Curator
L. P. Gratacap, Ph.B., A.B., A.M., Curator of Mollusca
William Beutenmüller, Associate Curator of Lepidoptera
John A. Grossbeck, Assistant

Prof. William Morton Wheeler, Ph.D., Honorary Curator of Social Insects
Alexander Petrunkevitch, Ph.D., Honorary Curator of Arachnida
Prof. Aaron L. Treadwell, B.S., M.S., Ph.D., Honorary Curator of Annulata
Charles W. Leng, B.S., Honorary Curator of Coleoptera

ICHTHYOLOGY AND HERPETOLOGY
Prof. Bashford Dean, A.B., A.M., Ph.D., Curator of Fishes and Reptiles
Louis Hussakof, B.S., Ph.D., Associate Curator of Fishes
John T. Nichols, A.B., Assistant Curator of Recent Fishes
Mary Cynthia Dickerson, B.S., Assistant Curator of Herpetology

MAMMALOGY AND ORNITHOLOGY
Prof. J. A. Allen, Ph.D., Curator
Frank M. Chapman, Curator of Ornithology
Roy C. Andrews, A.B., Assistant Curator of Mammalogy
W. De W. Miller, Assistant Curator of Ornithology

VERTEBRATE PALÆONTOLOGY
Prof. Henry Fairfield Osborn, A.B., Sc.D., LL.D., D.Sc., Curator Emeritus
W. D. Matthew, Ph.B., A.B., A.M., Ph.D., Curator
Walter Granger, Associate Curator of Fossil Mammals
Barnum Brown, A.B., Associate Curator of Fossil Reptiles
William K. Gregory, A.B., A.M., Ph.D., Assistant Curator

ANTHROPOLOGY
Clark Wissler, A.B., A.M., Ph.D., Curator
Pliny E. Goddard, A.B., A.M., Ph.D., Associate Curator
Robert H. Lowie, A.B., Ph.D., Assistant Curator
Herbert J. Spinden, A.B., A.M., Ph.D., Assistant Curator
Charles W. Mead, Assistant
Alanson Skinner, Assistant

PHYSIOLOGY
Prof. Ralph W. Tower, A.B., A.M., Ph.D., Curator

PUBLIC HEALTH
Prof. Charles-Edward Amory Winslow, S.B., M.S., Curator
John Henry O'Neill, S.B., Assistant

WOODS AND FORESTRY
Mary Cynthia Dickerson, B.S., Curator

BOOKS AND PUBLICATIONS
Prof. Ralph W. Tower, A.B., A.M., Ph.D., Curator

PUBLIC EDUCATION
Prof. Albert S. Bickmore, B.S., Ph.D., LL.D., Curator Emeritus
George H. Sherwood, A.B., A.M., Curator

American Museum of Natural History

GENERAL GUIDE

TO THE

EXHIBITION HALLS

MAGNA OPERA DOMINI EXQUISITA IN OMNES VOLUNTATES EJUS · PS. CXI. 2 · AMERICAN MUSEUM OF NATURAL HISTORY · INCORPORATED 1869

NO. 35 OF THE GUIDE LEAFLET SERIES

PUBLISHED BY THE MUSEUM, NOVEMBER, 1911

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

THE MUSEUM IS OPEN FREE TO THE PUBLIC ON EVERY DAY IN THE YEAR.

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world. The membership fees are,

Annual Members	$ 10	Fellows	$ 500
Sustaining Members (Annual)	25	Patrons	1000
Life Members	100	Benefactors (Gift or bequest)	50,000

THE MUSEUM LIBRARY contains more than 60,000 volumes with a good working collection of publications issued by scientific institutions and societies in this country and abroad. The library is open to the public for reference daily — Sundays and holidays excepted — from 9 A. M. to 5 P. M.

THE MUSEUM PUBLICATIONS are issued in six series: The American Museum Journal, Annual Report, Anthropological Papers, Bulletins, Guide Leaflets and Memoirs. Information concerning their sale may be obtained at the Museum Library.

GUIDES FOR STUDY OF EXHIBITS are provided on request by the Department of Public Education. Teachers wishing to bring classes should write or telephone the Department for an appointment, specifying the collection to be studied. Lectures to classes may also be arranged for. In all cases the best results are obtained with small groups of children.

WORKROOMS AND STORAGE COLLECTIONS may be visited by persons presenting membership tickets. The storage collections are open to all persons desiring to examine specimens for special study. Applications should be made at the information desk.

THE MITLA RESTAURANT in the east basement is reached by the elevator and is open from 12 to 5 on all days except Sundays. Afternoon Tea is served from 2 to 5. The Mitla Room is of unusual interest as an exhibition hall being an exact reproduction of temple ruins at Mitla, Mexico.

Scientific Staff

DIRECTOR
Frederic A. Lucas, Sc.D.

GEOLOGY AND INVERTEBRATE PALÆONTOLOGY
Edmund Otis Hovey, A.B., Ph.D., Curator

MINERALOGY
L. P. Gratacap, Ph.B., A.B., A.M., Curator
George F. Kunz, A.M., Ph.D., Honorary Curator of Gems

INVERTEBRATE ZOÖLOGY
Prof. Henry E. Crampton, A.B., Ph.D., Curator
Roy W. Miner, A.B., Assistant Curator
Frank E. Lutz, A.B., A.M., Ph.D., Assistant Curator
L. P. Gratacap, Ph.B., A.B., A.M., Curator of Mollusca
William Beutenmüller, Associate Curator of Lepidoptera
John A. Grossbeck, Assistant

Prof. William Morton Wheeler, Ph.D., Honorary Curator of Social Insects
Alexander Petrunkevitch, Ph.D., Honorary Curator of Arachnida
Prof. Aaron L. Treadwell, B.S., M.S., Ph.D., Honorary Curator of Annulata
Charles W. Leng, B.S., Honorary Curator of Coleoptera

ICHTHYOLOGY AND HERPETOLOGY
Prof. Bashford Dean, A.B., A.M., Ph.D., Curator of Fishes and Reptiles
Louis Hussakof, B.S., Ph.D., Associate Curator of Fishes
John T. Nichols, A.B., Assistant Curator of Recent Fishes
Mary Cynthia Dickerson, B.S., Assistant Curator of Herpetology

MAMMALOGY AND ORNITHOLOGY
Prof. J. A. Allen, Ph.D., Curator
Frank M. Chapman, Curator of Ornithology
Roy C. Andrews, A.B., Assistant Curator of Mammalogy
W. De W. Miller, Assistant Curator of Ornithology

VERTEBRATE PALÆONTOLOGY
Prof. Henry Fairfield Osborn, A.B., Sc.D., LL.D., D.Sc., Curator Emeritus
W. D. Matthew, Ph.B., A.B., A.M., Ph.D., Curator
Walter Granger, Associate Curator of Fossil Mammals
Barnum Brown, A.B., Associate Curator of Fossil Reptiles
William K. Gregory, A.B., A.M., Ph.D., Assistant Curator

ANTHROPOLOGY
Clark Wissler, A.B., A.M., Ph.D., Curator
Pliny E. Goddard, A.B., A.M., Ph.D., Associate Curator
Robert H. Lowie, A.B., Ph.D., Assistant Curator
Herbert J. Spinden, A.B., A.M., Ph.D., Assistant Curator
Charles W. Mead, Assistant
Alanson Skinner, Assistant

PHYSIOLOGY
Prof. Ralph W. Tower, A.B., A.M., Ph.D., Curator

PUBLIC HEALTH
Prof. Charles-Edward Amory Winslow, S.B., M.S., Curator
John Henry O'Neill, S.B., Assistant

WOODS AND FORESTRY
Mary Cynthia Dickerson, B.S., Curator

BOOKS AND PUBLICATIONS
Prof. Ralph W. Tower, A.B., A.M., Ph.D., Curator

PUBLIC EDUCATION
Prof. Albert S. Bickmore, B.S., Ph.D., LL.D., Curator Emeritus
George H. Sherwood, A.B., A.M., Curator

THE AMERICAN MUSEUM OF NATURAL HISTORY OF WHICH THE CORNER STONE WAS LAID IN 1874 BY PRESIDENT U. S. GRANT.

This is the Southern Façade which measures 710 feet from tower to tower. Eastern, western and northern façades comparable with this in length are designed for the completed structure, which will be larger than any building in the world to-day even the Escorial of Spain or the National Capitol at Washington

GENERAL GUIDE

TO THE

Exhibition Halls

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

Prepared by GEORGE H. SHERWOOD
Curator of Public Education

NO. 35

OF THE

GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

MARY CYNTHIA DICKERSON, Editor

New York. Published by the Museum. November, 1911

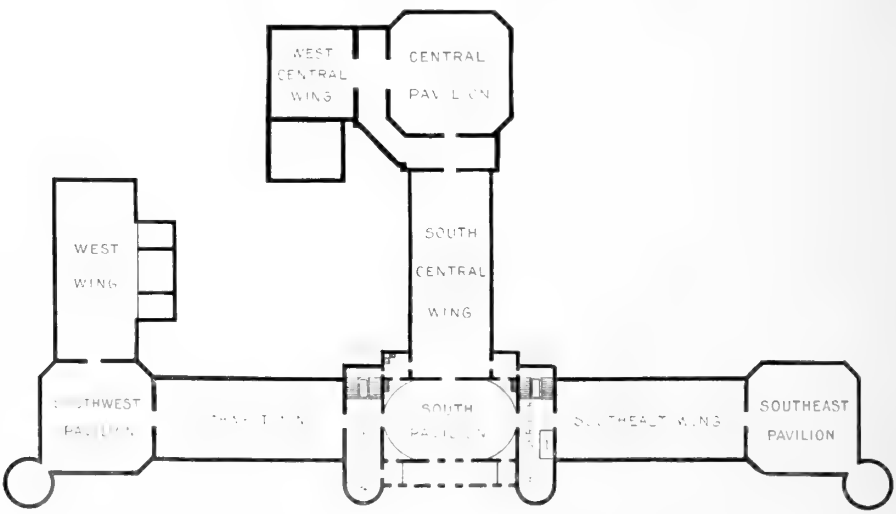
CONTENTS

PREFATORY NOTE

It is the purpose of this Guide to call attention to the more important exhibits that the visitor will see as he passes through the halls. More detailed information regarding the specimens may be obtained from the labels or from the *Guide Leaflets.*

It is frequently necessary to rearrange the exhibits in the halls in order to provide space for new material which is continually being received or to put into effect advanced ideas regarding methods of exhibition. In some instances therefore, the arrangement described is not wholly that in existence at the date of issue of the Guide, but rather what will be when certain installations now in progress are completed. This is true for the halls devoted to geology and invertebrate palæontology and to some extent in the exhibit of the Indians of the Woodlands and in those of local mammals, mammals of the world and insects. The sergeants on each floor will always direct the visitor to any collection on the given floor

American Museum of Natural History, *November, 1911.*



The halls are named according to the position they will have in the completed Museum building, which will consist of four long façades facing east, west, north and south respectively, each connected with the center of the quadrangle formed, by a wing extending between open courts. Thus the hall at the eastern end of the south façade (the only façade completed) becomes the "southeast pavilion."

INDEX OF EXHIBITION HALLS

"AHNIGHITO", THE LARGEST AND HEAVIEST METEORITE KNOWN

The Eskimos discovered this meteorite where it had lain for probably thousands of years on the Greenland coast near Cape York, and Admiral Peary brought it to New York. The meteorite's weight of thirty-six tons is supported independently of the Museum building on a solid pedestal of concrete built up through the floor from rock beneath the cellar

GENERAL GUIDE TO THE MUSEUM

INTRODUCTION

History

THE American Museum of Natural History was founded and incorporated in 1869 for the purpose of establishing a Museum and Library of Natural History; of encouraging and developing the study of Natural Science; of advancing the general knowledge of kindred subjects and to that end, of furnishing popular instruction. For eight years its temporary home was in the Arsenal in Central Park. The corner stone of the present building in Manhattan Square was laid in 1874 by President U. S. Grant, and in 1877 the first section (South Central Pavilion) was completed.

Location

Hours of Admission

The Museum is located at 77th Street and Central Park West, and can be reached by the 8th or 9th Avenue surface cars, the 6th or 9th Avenue elevated to 81st Street station, or by the subway to 72nd or 79th Street station. The Museum is open free every day in the year; on week days from 9 A. M. to 5 P. M., on Sundays from 1 to 5 P. M.

The Museum building is one of the largest municipal structures in the City, and has cost approximately $5,000,000. The South Façade is 710 feet in length; the total area of the floor space is 470,789 square feet, or about 10 acres, of which 271,886 square feet are open to the public. The building when completed is designed to occupy all of Manhattan Square.

Administration and Support

The Museum is under the control of a self-perpetuating Board of Trustees, which has absolute control of all property of the Museum and the entire direction of its activities. The Trustees give their services without remuneration.

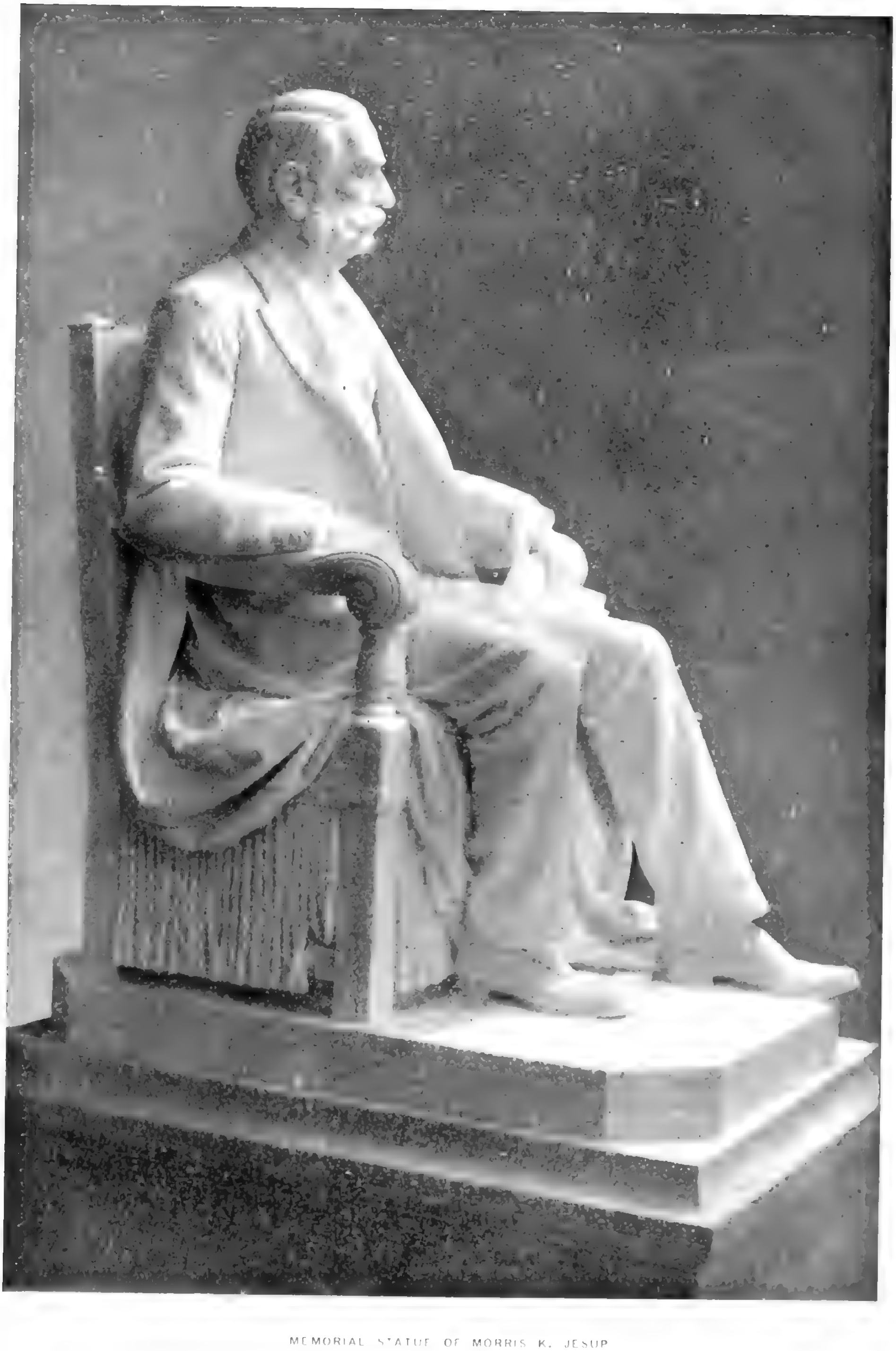
The Museum building is erected by the City and leased to the Trustees. The Museum derives its chief financial support from four sources:

1. The City, which provides annually an appropriation ($189,757 in 1911) for the maintenance of the building and the exhibition of the collections. Such appropriations are not available however for purchase of specimens, carrying on of field work or publication of scientific papers.

2. Endowment, a total of $2,365,750 (1911), which yields an annual income of $109,540.

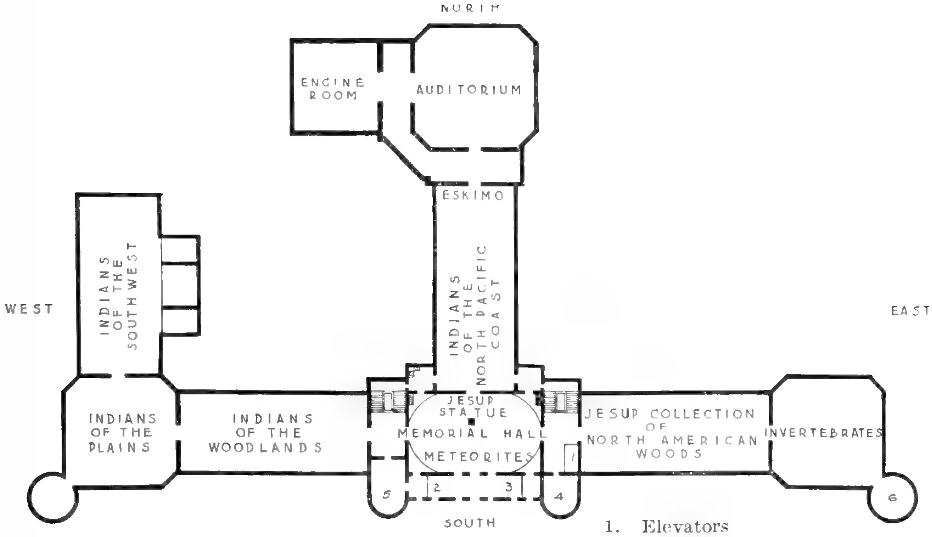
3. Membership, there being at present more than 2000 Members each contributing annually $10 or more for the support of the Museum. Membership fees total approximately $25,000 per year, and are used for the purchase of specimens, for exploration and for publication.

4. Voluntary contributions of Trustees and other friends of the Museum, which are more than $80,000 for the year 1911.



MEMORIAL STATUE OF MORRIS K. JESUP

Mr. Jesup, President of the American Museum of Natural History for more than a quarter of a century, was a staunch supporter of the institution's two aims, to be a great educational institution for the people and also a center for activity in scientific research



1. Elevators
2. Information Bureau
3. Waiting Room
4. Academy Room
5. West Assembly Room
6. Collection of Corals

FIRST FLOOR

SOUTH PAVILION

Memorial Hall

Information Bureau

The *Information Bureau* and the *Checking Room* are at the south entrance. Wheel chairs for children or adults are available without charge. Postcards, photographs, guide leaflets, and Museum publications of various sorts are for sale here. On the right and left of the entrance are small *Assembly Halls* in which lectures to classes from the public schools of the City are given and where the New York Academy of Sciences and other scientific societies hold their meetings.

Statue of Morris K. Jesup

From the lobby the visitor first enters *Memorial Hall* and faces the marble statue of Morris K. Jesup, third President of the Museum. Mr. Jesup was a founder, trustee and benefactor of the Museum and for twenty-seven years its President. Under his administration and through his liberality the Museum made

rapid progress. This statue of Mr. Jesup was executed by William Couper and was presented to the Museum by the Trustees and a few other friends. The marble busts in the wall niches represent noteworthy pioneers of American science, and are the gift of Morris K. Jesup. These include Benjamin Franklin, statesman and natural philosopher, Alexander von Humboldt, geographer and geologist, Louis Agassiz, zoölogist, Joseph Henry, physicist, John James Audubon, ornithologist, Spencer Fullerton Baird, zoölogist and founder of the United States Fish Commission, James Dwight Dana, geologist, John Torrey, botanist, Edward Drinker Cope, palæontologist, and Joseph Leidy, anatomist.

Meteorites

Circling this same hall is the collection of meteorites, popularly known as "shooting stars," ranging in weight from a few grains to 36 tons. The greater number of meteorites are stony, but the more interesting ones are composed chiefly of iron, while certain meteorites contain both stone and iron. The toughness of iron meteorites is due to the presence of nickel, and the fact that they were so difficult to cut led to the adoption of an alloy of nickel and iron in making the armor plate for battleships. Meteorites have a very definite structure and when polished (see specimens on the right with electric lamp) show characteristic lines which together with their composition are to the expert absolute proof that the specimens are meteorites.

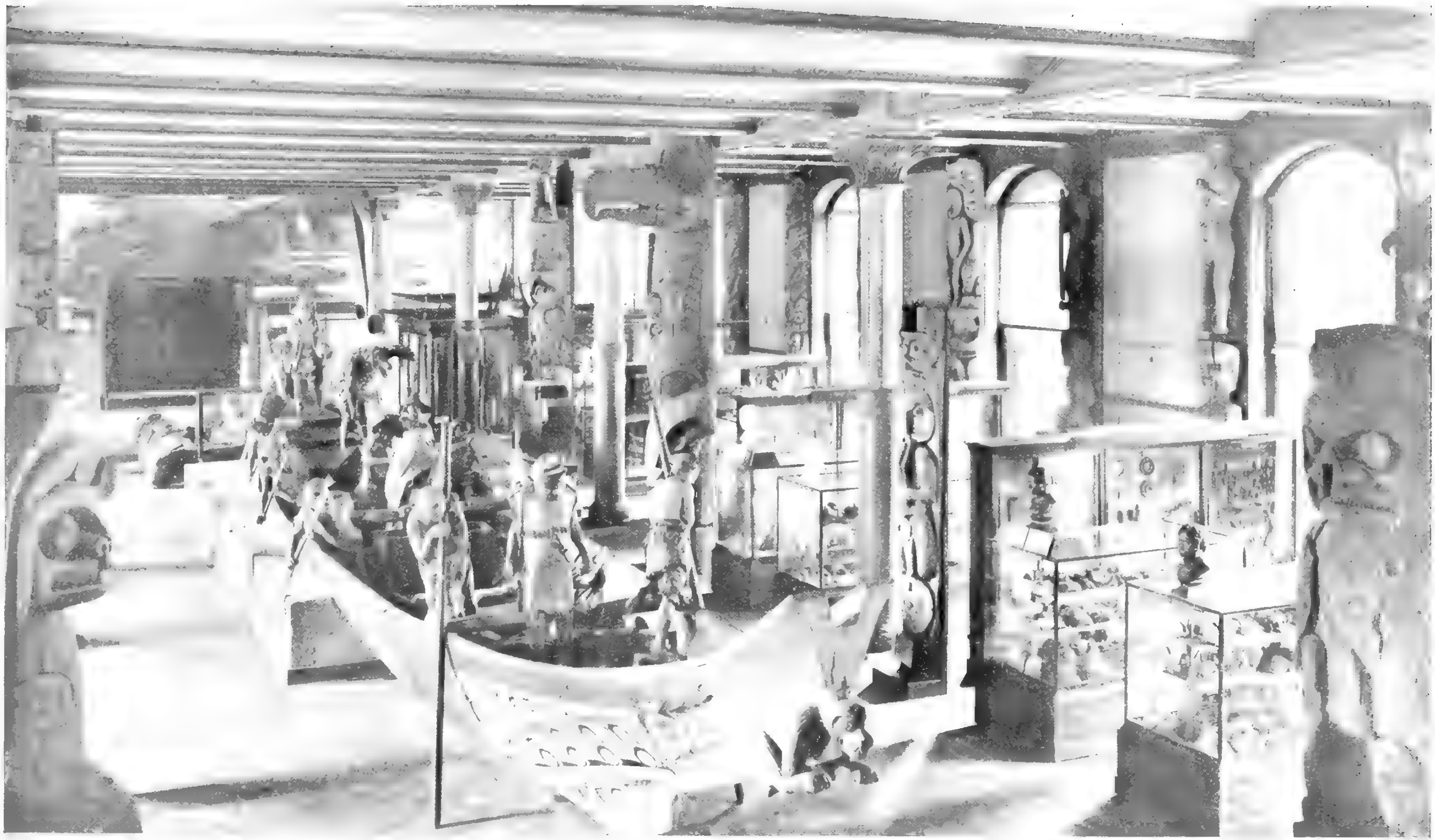
Ahnighito Meteorite

"Ahnighito" or "The Tent" at the left is the largest known meteorite in the world, and was brought from Cape York, Greenland, by Admiral R. E. Peary. It weighs 36 tons, and its transportation to New York was an engineering feat. Opposite it at the right is the curiously pitted "Willamette" meteorite from Oregon which was the subject of a famous lawsuit. [The collection of meteorites is fully described in *Guide Leaflet* No. 26.]

Willamette Meteorite

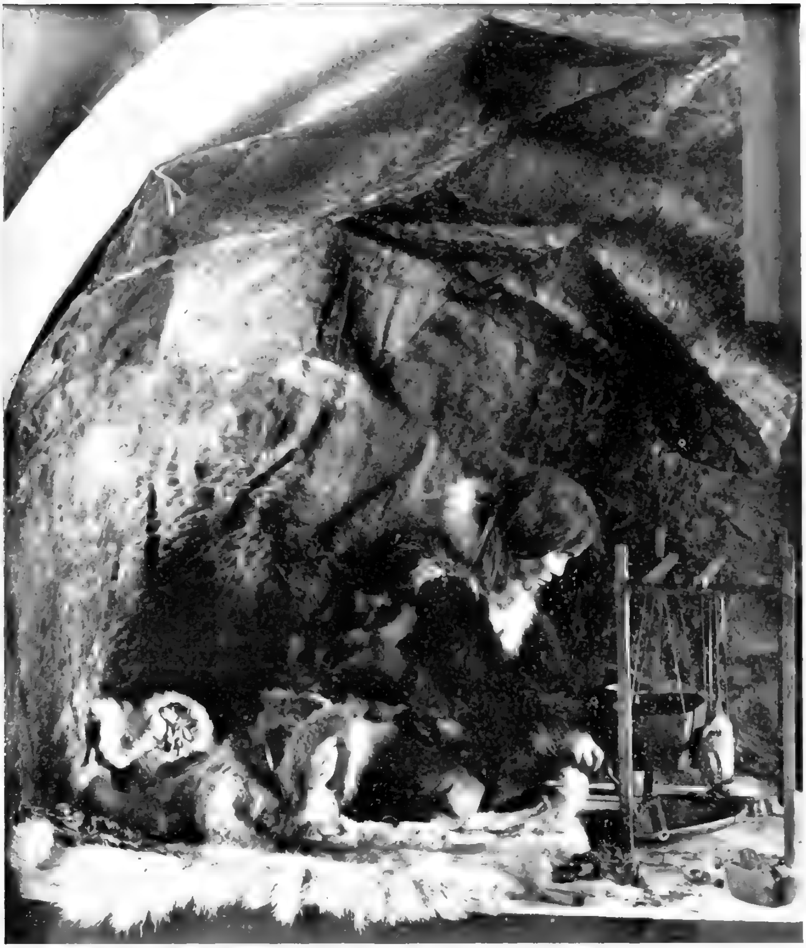
Model of Solar System

Suspended in the center of the room is a three-inch incandescent globe representing the sun. Standing directly beneath this globe one may see suspended from the ceiling other lights representing the four planets of the Solar System which are nearest the sun, and installed in such a manner as to show relative size and distance from the sun, and orbit around the sun. The respective orbits are subdivided into sections representing the solar day, and the relative diurnal position of each planet is shown. The "Signs of the Zodiac" are imbedded in the floor.



NORTH PACIFIC HALL AND THE CEREMONIAL HAIDA CANOE

This canoe, dug out from a single tree trunk, is 64½ feet long, large enough to contain forty figures. These figures when completed will be representative in physique, dress and action of the Indian tribes of the Alaskan coast one hundred years ago. The canoe was brought to the Museum from the Skeena River, Alaska, in 1883



ESKIMO HOME SCENE

There are two notable groups near the entrance to the Auditorium and underneath the Stokes mural paintings of the Land of the Midnight Sun. In one, a home scene within a snow house or "igloo," an Eskimo woman is cooking blubber over the flame from a seal oil lamp. The Museum is rich in Eskimo collections

SOUTH CENTRAL WING

Indians of the North Pacific Coast

Indians of British Columbia and Alaska

North of Memorial Hall, that is to the rear of the Jesup statue, is the *North Pacific Hall* where are displayed collections illustrating the culture of the Indians of the Northwest Coast of America and also of the Eskimo. These collections are arranged geographically so that in passing from south to north through the hall the visitor meets the tribes in the same sequence that he would in traveling up the west coast of North America.

The most striking object is the great Haida Canoe in the center of the hall with its party of Chilkat Indians celebrating the rite of the "potlatch." The potlatch is the great "giving ceremony," common to all the coast tribes, when individuals and families gladly impoverish themselves that the dead may be honored, the emblem of the clan exalted and social standing recognized or increased, while underlying the potlatch as a social function is a deep religious fervor in the worship of ancestry and communion with the dead. At the stern of the canoe, which is represented as approaching the beach, stands the chief or "medicine man," who directs the ceremony. The canoe is a huge dugout made from a single tree, is 64 feet long and 8 feet wide and capable of carrying 40 men.

Haida Canoe

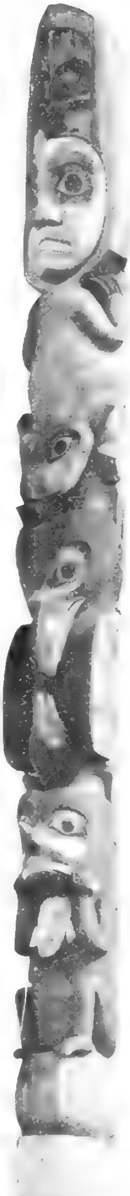
Against the pillars and walls of the hall are many house posts and totem poles with their grotesque carvings; the latter may represent either the coat of arms or family tree, or they may illustrate some story or legend connected with the family. The Haida Indians together with the Tlingit are recognized as superior to the other Indian tribes along the Northwest Coast of North America. They are divided into a number of families with various crests for each family and grouped into two main divisions, the Ravens and the Eagles. The Tlingit are makers of the famous Chilkat blankets, of which the Museum possesses an exceptionally fine collection. Among some of the other tribes there is little wool weaving, the clothing consisting of shredded and softened inner tree bark braided and matted together. The Indians of this region are preëminently a woodworking people, as is manifest in the exhibit. Religious ceremonies and the wearing of masks generally supposed to aid the shaman or priest in curing disease, were customary among most of the tribes. The masks represented guardian spirits and by wearing them the shaman impersonated these spirits.

Totem Poles

Chilkat Blankets

Religious Ceremonies

The north end of the hall is devoted to Eskimo collections. The cases on the right show the manner of dress, method of transportation, etc., also cooking



Modern totem pole at Wrangel, Alaska. Many totem poles are huge cedar carvings so old that the Indians themselves have forgotten their meaning

utensils and bonework. Notice how many of the utensils, weapons and clothing are made from the skin or bone of the seal, walrus and other Arctic animals. The case marked "Eskimo Woman Cooking" shows a section of the interior of a snow hut or igloo lined with seal-skin, the mother preparing the food in a primitive stone vessel, heated by flame from seal oil in the stone lamp below. The opposite case shows an Eskimo woman fishing through the ice. She has formed a windbreak with blocks of ice. The fish-rod and hook, and the long ladle are made of bone, and with this latter she keeps the water in the hole from freezing over while she is fishing.

Eskimo Collections

The mural decorations of Arctic scenery are by Frank Wilbert Stokes, and the legend depicted on the main canvas over the door is given in full in *Guide Leaflet* No. 30; the mural decorations illustrating the industries of British Columbia and Alaska are by Will S. Taylor.

Mural Decorations

The doorway at the north end of the hall leads to the *Auditorium* which has a seating capacity of 1400, and is equipped with two screens, 25 feet square, for stereopticons. Free public lectures are given here Tuesday and Saturday evenings from October to May under the auspices of the Board of Education. There are also free lectures on public holidays, and special lectures for Members of the Museum as well as lectures for school children.

Auditorium

At the end of the corridor is the power room where may be seen demonstrated the transformation of the potential energy of coal into heat, light and motion.

Power Room

[*Return to the Jesup Memorial Statue.*]

WEST CORRIDOR

To the right or west of the Jesup statue are three halls devoted to Indian collections. To reach these the visitor passes through the *West Corridor* containing the Ward-Coonley collection of meteorites which numbers 603 "falls" and is the most complete collection of meteorites in the world.

Ward-Coonley Meteorites

SOUTHWEST WING

Indians of the Woodlands

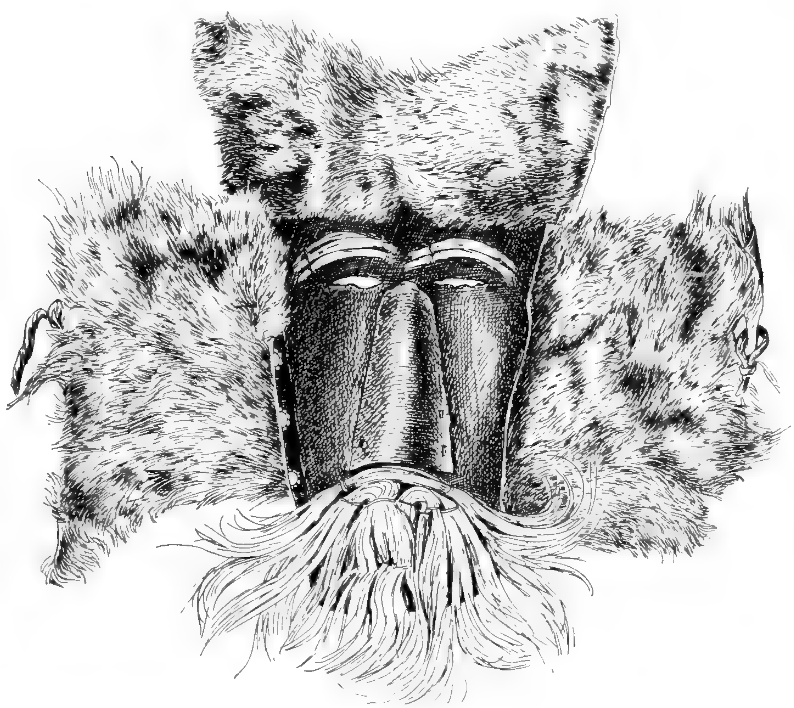
Indians of the Woodlands

The first hall to the west contains the collections pertaining to the Indians of the Woodlands. These Indians include all tribes east of the Mississippi and are therefore those connected with the very early history of the country. In the eastern section of this hall are the New York State Indians of whom the Iroquois are the most important because of their superiority in organization and power.

Carved birch bark kettle of the Penobscot Indians.

Iroquois

The League of the Iroquois, or the Five Nations, comprised the Mohawk, Seneca, Oneida, Onondaga and Cayuga, later the Tuscarora, when it was styled the Six Nations.



Cherokee mask, Indians of the Woodlands, North Carolina. Such masks were worn by members of "False Face" Societies supposed to be able to counteract the work of evil spirits and to heal sickness

This league was formed probably as early as 1539 and with the purpose, as its founders boasted, of bringing peace and breaking up the spirit of perpetual warfare. It is interesting to note that the Indians recommended it as a model to the colonies. The Oneida Indians were the only members of this league who, as a tribe, adhered to the colonists in the war of the Revolution.

In the wall case on the right are shown the dress, occupations and dwellings of the Iroquois. A life-size model of an Iroquois representing a messenger is holding out a belt of wampum. This wampum, made chiefly of the shells of the "quahog" or common hard clam of our markets, was utilized in various ways: It was greatly prized as an ornament and as trimming on garments; was an important feature in religious ceremonies and festivals, being the token by which the Indians confessed and took oaths; and was the object by which public transactions were commemorated. Wampum was not used as currency however, the Indians having no standard of value until they found it in our currency, but it did come nearer currency than any other kind of property, and when sold to white settlers the strings were counted and reckoned at half a cent a bead. The woman in the right of the case is pounding corn in a primitive mortar. (Corn and tobacco are our legacies from the Indian.) The matrons of the Iroquois owned their own property in distinction from their husbands; they sat in council by themselves and had the right to terminate a war.

Wampum

On the left is a collection of grotesque masks. These were worn by the False Face Societies. The Indians were very superstitious and believed in the existence of demons or evil spirits who were without bodies, legs or arms, and possessing hideous faces only, were characterized as "false faces." There eventually grew up a society calling itself the "False Face Band" whose members were supposed to have power to counteract the evil done by these demons and to possess the capacity to heal sickness. Pictures by De Cost Smith illustrating this society are on exhibition in this hall.

"False Faces"

The earliest Indians of the vicinity of New York City are represented by the archæological collections in the first alcove on the left. Here will be seen remnants of their crude pottery, weapons, cooking utensils, and various implements made of stone, wood or bone, collected chiefly from burial sites on Manhattan Island, Staten Island and Long Island. On the top of one of the cases is a portion of an original dugout canoe which was excavated in Oliver Street in 1906 when a telephone conduit was being laid. This canoe and a large earthern pot are among the very few good specimens that have ever been found representative of New York City Indians.

Local New York Indians

The collections of the remaining tribes of the Woodland Indians are in process of installation and will be treated in the following order: On the right or northern side of the hall, the Cherokee, Seminole, Menomini, Sauk and Fox, and Winnebago tribes; on the left or southern side of the hall, the Delaware, Ojibwa and Cree tribes. The Seminoles have never been entirely conquered. They moved into Florida and have taken up their abode in the Everglades, hostile to the white man whom they will not allow to enter their domain. This exhibit is one of the three existing collections from Seminole Indians.

Seminole

Among the Menomini specimens there is an excellent collection of medicine bags, porcupine quillwork and a buffalo skin headdress worn by a noted chief Oshkosh. The Menomini have always been friendly to the Americans.

Menomini

The Winnebago in Wisconsin claim to have built the mounds representing animals in the neighborhood. The Winnebago and the Delawares are linguistically related.

Winnebago

Examples of clothing are shown in the collections of the eastern Cree who live in Labrador. Among these examples is a twisted rabbit skin, the Baby Bunting skin of fable. The garments of the eastern Cree are painted rather than worked with beads.

Cree

The Ojibwa made maple sugar. Examples of their picture writing on strips of birch bark, descriptions of ceremonies and songs, are on exhibition; also a number of birch bark baskets. Hiawatha was a member of this tribe.

Ojibwa

Among the Delaware collections is a doll that was worshipped by this tribe as the guardian of health. Indians of the vicinity of New York City resemble this tribe more nearly than any other. The Indians of Manhattan and vicinity are described in *Guide Leaflet* No. 29.

Delaware

SOUTHWEST PAVILION

Indians of the Plains

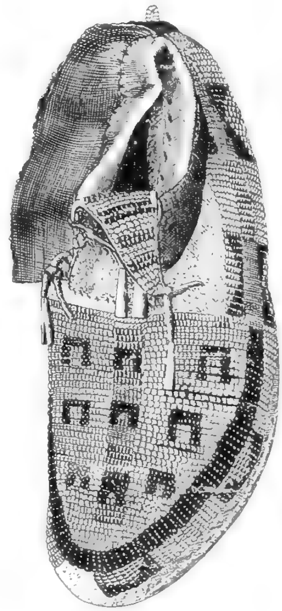
The collections of the Indians of the Plains will be found in the hall adjoining. These Indians comprised the tribes living west of the Mississippi and east of the Rocky Mountains as far south as the Valley of the Rio Grande and as far north as Saskatchewan. They include the Plains Cree, Dakota, Crow and Blackfoot shown on the left of the hall, and the Mandan, Pawnee, Kiowa and Cheyenne on the right. All these tribes were dependent on the buffalo, so much so that they have sometimes been called the "Buffalo

Indians of the Plains

A MEDICINE MAN'S TIPI, OBTAINED IN MONTANA, 1903

The interior shows the family life of a Blackfoot Indian. The man and woman are engaged in household tasks, a tobacco board and pipe are in place for guests, the ashes of the family altar tell of many incense-sprinkled coals that have burned down there

Indians." Buffalo flesh was their chief food, and buffalo skin they made into garments. A buffalo paunch was used for cooking and buffalo horns were made into various implements of industry and war. The spirit of the buffalo was considered a powerful ally and invoked to cure sickness, to ward off evil and to give aid in the hunt. Wherever the buffalo herds led the way, the Indians moved their tents and followed. With the extermination of the buffalo the entire life of the Plains Indians was revolutionized.



A beaded moccasin from the Indians of the Plains, (Gros Ventre)

Blackfoot Tipi

In the center of this hall is a genuine Blackfoot Indian tipi with a painting of an otter on one side. This tipi belonged to a medicine man of that tribe, who claimed to have miraculous assistance from the otter.

Societies

There were numerous societies among the Plains Indians which included practically all grown Indians. A special dance was required prior to entering these societies. The costumes worn on such occasions are shown in this hall. There were other dances connected with their religious ceremonials, the best known and most important of which is the sun dance illustrated by a model at the left of the tipi. The sun dance was held annually in the early summer in fulfillment of a vow made during the preceding winter by some member of the tribe who wished a sick relative to recover. The dance involved great physical endurance and excruciating self-torture, lasting three days, during which time the dancers neither ate nor drank.

Sun Dance

Medicine Pipe

At the entrance to the tower room is a genuine medicine pipe, held in awe by the Indians and dearly parted with; also the contents of a medicine pipe bundle. The contents of another medicine bundle, belonging to a learned man of the tribe (medicine man), together with the headdress which he wore when visiting the sick, is in a case near.

The Plains Indians are noted for their picture writing on skins and for their quillwork which has now been superseded by beadwork. [See *Guide Leaflet* No. 15.]

WEST WING

Indians of the Southwest

Indians of the Southwest

THE hall to the north is devoted to the Indians of the Southwest, neighbors of the Plains Indians. They comprise those tribes west of the eastern border of the Rocky Mountains living in the southern part of Utah and Colorado, in Arizona, in New Mexico and in Northern Mexico. The hall is divided into two main sections: on the left are the sedentary Indians — the Rio Grande Pueblo, the prehistoric Pueblo Bonito, the Hopi, the prehistoric Cliff Dwellers and the Zuni; on the right are the nomadic Indians — the eastern Apache, Apache, Navajo, Pima, and the Indians of Northern Mexico. The sedentary Indians were peaceful and agricultural, made pottery, dwelt in adobe houses and lived from age to age in one location. The nomadic tribes were warlike and hunters, made baskets, lived in tipis of buffalo skin and brush, and moved from place to place since they would not live in an adobe where death had occurred. At the entrance to this hall are models of Indian villages at Acoma and De Taos. An examination of these will give the visitor a correct idea of the manner of living, the character of the houses, churches and kivas, and the lay of the land. The Acoma mesa is near the "Enchanted Mesa" so surrounded by mystery. Material collected from the Acoma tribe is found farther on in the hall and is described on p 26.

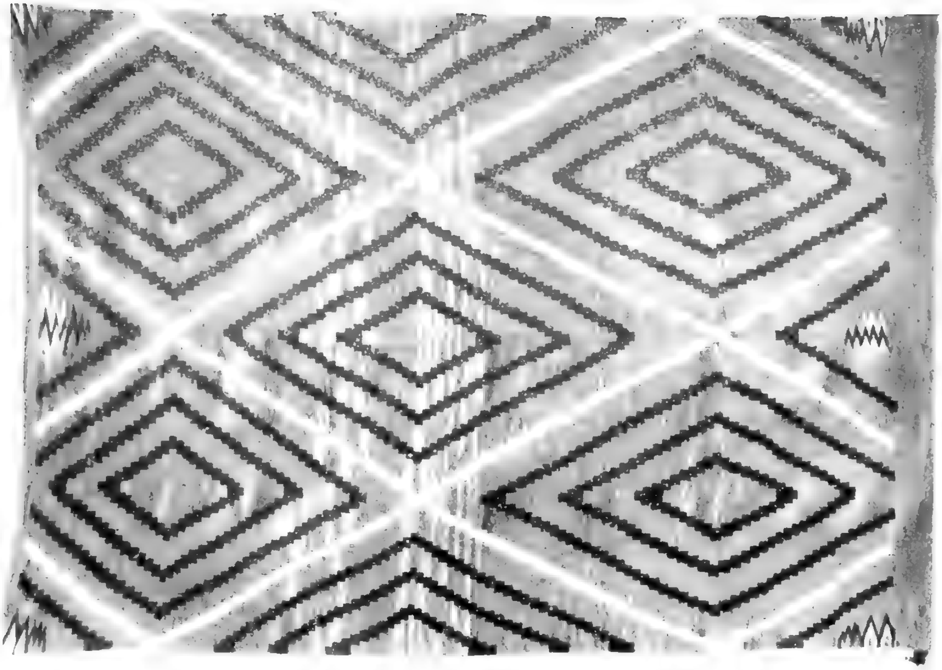
Models of Pueblo Villages of Acoma and De Taos

On the left in a wall case are shown samples of pottery. This industry was foremost among the sedentary Indians because the question of transportation did not have to be considered. Their food products of corn, beans, squash, cornmeal, bread, etc., are in the next case; and examples of their ornaments, costumes and war implements are shown farther on.

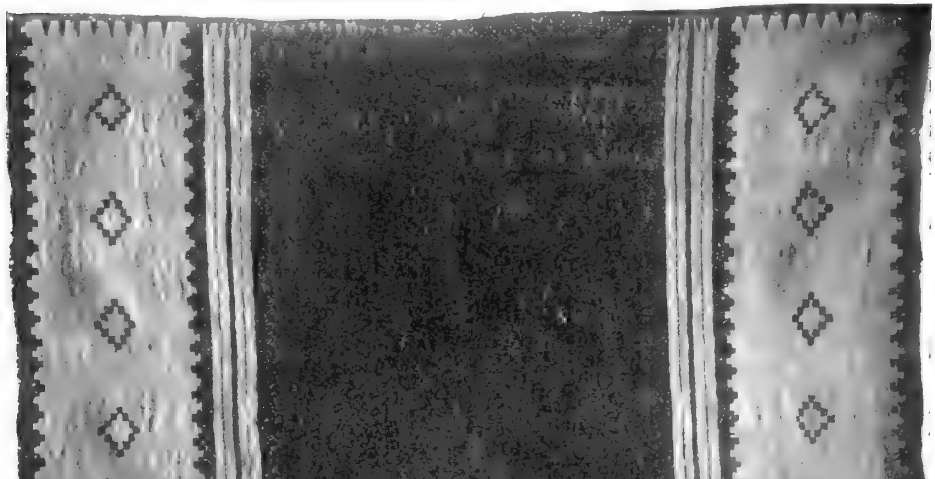
Rio Grande Pueblo

The Hyde collection of very distinctive black and white pottery in the wall cases on the west is from the prehistoric Pueblo Bonitos. In an adjoining case is pottery from Rio Tuleroda, representing a prehistoric and absolutely unknown tribe. Prehistoric inlaid work and remarkable work with turquoise in other cases near belong to the Pueblo Bonito tribe. Sandals, basketry, pottery, bags made of the yucca plant, examples of weaving, and two mummies are from the prehistoric Cliff Dwellers whose houses are represented by models along the wall. A most extraordinary fragment of a blanket remarkable for its texture and design is in a glass frame in one of the cases.

Prehistoric Tribes



An attractive Navajo blanket from the Museum's valuable collection. The Navajo Indians of the Southwest are a wealthy pastoral people and the only Indian blanket-makers of North America.



Navajo woman's blanket of black and bayeta red. The woman's dress is made by sewing together two blankets along the sides and one end, leaving openings for head and arms. Bayeta blankets, not made since 1875, are the oldest and most valuable of Navajo weaving; each contains some amount, small or large, of red yarn ravelled from Spanish military uniforms

The Hopi are the people of the snake dance. One case contains the costume and insignia used in the dance, and another ceremonial plaques.

Hopi

The Zuni were first visited and described by the Spanish in 1540. For three hundred years and over they have resisted the inroads of Christianity and in spite of missionaries and churches, they still maintain their own religious ceremonies. Some of their ceremonial masks and idols are in a near case. The wearing apparel and pottery of the Acoma and Zuni are in the northern part of the room. In one case a collection of saddles, plows and various implements is evidence of Spanish influence on the Indian.

Zuni

Continuing around the hall, the visitor comes to the case containing the serapes, blankets of wonderful design and texture made by the Mexican Indians, particularly near Saltillo. They were made for the wealthy Spaniards and were worn as ponchos or simply thrown over the shoulder. A serape is made at the present day, but it is quite different from the old-time serape. One case holds a model of a Mexican Indian woman weaving a serape and a man mending an arrow.

Mexican Indian

The Pima race, next in order in the hall, extends into Mexico. These are desert people, using the giant cactus, century plant and juniper berries for food.

Pima

To the Navajo Indian is justly acceded superiority in the field of weaving. Navajo blankets are of unusual beauty and design and are made from the wool obtained from their own sheep (introduced into the region by the Spaniards) which they herd in great numbers. To-day the blankets they weave are almost all sold, while they buy machine-made blankets for their own use. One case contains valuable bayeta blankets, named such because the red in them was obtained from ravelled "bayeta" or flannel from Spanish military uniforms. The silversmith industry was introduced among these Indians by the Mexicans, and the buckles, bracelets and other ornaments exhibited are made from the Mexican silver dollar. In an adjoining case are displayed the tools used in this work.

Navajo

The Apache of the Southwest were not as warlike as the eastern Apache, but lived on their own land and wove and made baskets. The eastern Apache raided the country belonging to the Plains Indians for buffalo, swooped down, captured their prey and returned before they were overtaken by their furious pursuers. The dress, ornaments and implements of the eastern Apache are similar to those of the Plains Indians. Their tipis also correspond in being made of buffalo skin. The case against the south wall contains examples of basketry, the pastime

Apache

FLOWERING DOGWOOD IN THE FORESTRY HALL

Each of the five hundred species of trees in North America is represented by a section of trunk five feet long, some of a diameter not found in the country's forests to-day. Many of the specimens are accompanied by wax models of leaves, flowers and fruits accurately reproduced from life.

and industry of these moving peoples. [For data on the Basket Makers of Southeastern Utah see *Guide Leaflet* No. 6.]

[*Return to the Jesup Statue.*]

EAST CORRIDOR

Polar Maps

Leaving the statue on the left and "Willamette" meteorite on the right and going east the visitor enters the corridor where the elevators are located (*East Corridor*). Here will be found maps of the north and south polar regions showing the routes of explorers. On the wall by the north polar map are the sledges used by Admiral Peary in his last three expeditions in search of the North Pole. The Morris K. Jesup sledge which the Admiral used in his successful polar expedition is the one nearest the entrance. The various sledges in their differences of style show the persistent effort made by Admiral Peary to bring the sledge up to its greatest possible usefulness. That he was successful on his last trip was in part due to the final modification. [A history of the south polar expeditions is given in *Guide Leaflet* No. 31.]

Polar Expeditions

Peary Sledges

SOUTHEAST WING

Jesup Collection of North American Woods

To the east of the elevators is the *Hall of North American Forestry* containing the Jesup Collection of North American Woods, a nearly complete collection of the native trees north of Mexico, presented to the Museum by Morris K. Jesup. The specimens show cross, longitudinal and oblique sections of the wood finished and unfinished, and the labels on the specimens give the distribution of the species, the characteristics of the wood and its economic uses. The trees are grouped by families and the location of each family will be found on the floor plan at the entrance of the hall. The reproductions of the flowers, leaves and fruits in natural size are instructive. This work is done in the Museum laboratories. Note the character of forests as shown by the transparencies. [For fuller information in regard to this hall see *Guide Leaflet* No. 32.]

Jesup Collection of North American Woods

SOUTHEAST PAVILION

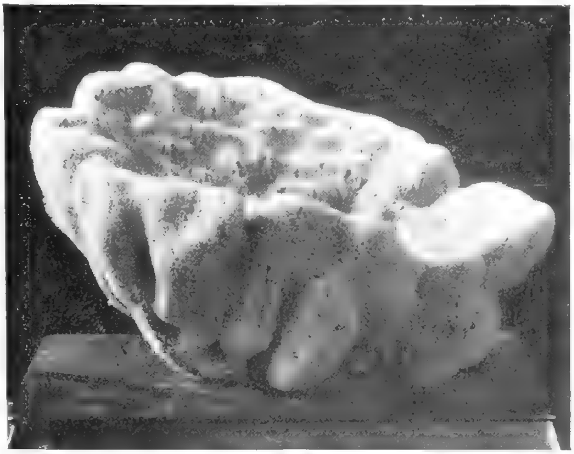
INVERTEBRATES

At the extreme east is *Darwin Hall*, devoted chiefly to the invertebrate animals (those which do not possess a backbone). The installation in the alcove cases is designed to give a synopsis of the Animal Kingdom and the relationships existing between the various groups. Passing around the hall from left to right, the progression is from the lowest forms of animal life, the one-celled Protozoa, to the highest and most complex forms of animal life, the Primates, including man. The distinctive characteristics of each group are fully described on the alcove and case labels. Many of the invertebrates, particularly among the lowest forms, are so small and their structures are so minute, that they can be seen only by the aid of a magnifying glass. In such instances the specimens are represented by skilfully prepared models in glass and wax showing the animal many times enlarged. Thus the visitor may obtain an idea of the form and structure of these animals which in spite of their small size have in so many instances such a vital influence on the life of man.

Synoptic Series

This alcove contains the lowest forms of animal life. All are single-celled individuals. They are found in stagnant water, and the ocean bottom in many localities is covered with them. The specimens exhibited in this alcove are models, some of which are enlarged more than a thousand diameters.

Alcove 1 Protozoa



European commercial sponge comparable with the Florida yellow sponge or "Hardhead." The sponge industry in both the Mediterranean and the Bahama region is almost destroyed by careless methods, and conservation must be practiced here as in other of the world's resources

Sponges are of two kinds. Those with skeletons or supporting structures of silica (i. e. flint) and those with skeletons of horn. The sponges

Alcove 2 Sponges

Marine Habitat Group. A community of starfishes, sea anemones, sea urchins, corals and sponges as seen below the edge of a coral reef in the Bahamas

of commerce belong to the latter class. In the specimens exhibited the skeleton only can be seen, the living tissue having been removed. Many of the glass sponges are very beautiful in design. Sponges range in size from the tiny Grantia of the New England coast to the gigantic "Neptune's goblets" found in the eastern seas. This alcove contains certain specimens whose tissue is represented in wax artificially colored to show the natural coloring of sponges, which varies from the bleached yellowish color commonly seen to deep brown or black, or yellow and red, in varying shades.

Alcove 3 Polyps

In Alcove 3 are shown coral animals and their relatives: plant-like hydroids which often are mistaken for sea moss, but which really are a series of polyps living in a colony; jellyfishes with their umbrella-shaped bodies and long streaming tentacles; brilliant colored sea anemones, sea fans and sea plumes; the magenta colored organ-pipe coral, and the precious coral of commerce. Coral polyps are the animals that build up the coral reefs (there is no coral "insect").

Alcove 4 Flatworms

The best known species in this group is the tapeworm, whose development and structure are accurately shown by the models in the central case. As will be seen, its structure is more complex than that of preceding forms.

Alcove 5 Round-worms These are for the most part parasitic, living in the digestive canals of mammals. The most familiar is the common roundworm or stomach worm, *Ascaris*, of which an enlarged model is exhibited.

Alcove 6 Rotifers The wheel animalcules comprise many exquisite and grotesque forms, some of which construct tubes of gelatinous substance, sand-grains, etc. A few of the species are parasites, but most of them live a free, active life. They are aquatic, more abundant in fresh water.

Alcove 7 Sea-mats The sea-mats in Alcove 7 are plant animals which lead the colonial form of life. The majority of the species are marine, although a few occur in fresh water. The lamp shells shown in this alcove superficially resemble clams, but by structure are more closely related to the worms and starfishes.

Alcove 8 Starfish Alcove 8 is occupied by the starfishes, the sea urchins, sea cucumbers and sea lilies. The starfish is the pest of the oyster beds as it feeds on oysters and destroys them in large numbers. Starfish have the power of self-mutilation, i. e. when handled or attacked they are able to drop off an arm and later regenerate another. Sea urchins are an important article of food in Europe and the West Indies.

Alcove 9 Annelids The annelids are worms whose bodies are made up of rings or segments. They are inhabitants of both fresh and salt water, many kinds living in the mud and sand of the shore while others bore into wood and shells. The "houses" that these annelids build are often very beautiful and interesting. The common earthworm is perhaps the most familiar of this group. In the window is a group showing a section of a mud flat on the New England coast with the variety of worm life found in what to the casual observer seems to be an uninhabited area.

Alcove 10 Arthropods Arthropods include the familiar crabs, lobsters, insects and their relatives. The number of existing species in this group is greater than that of all the rest of the animal and vegetable kingdoms together. No other group comprises so many species useful or harmful to man. In the case in the center of the alcove is a model showing the anatomy of the common lobster, also enlarged models showing heads of various species of insects. On the wall are two of the largest specimens of lobsters that have ever been taken. They weighed when alive thirty-one and thirty-four pounds respectively. The largest of the arthropods is the giant crab of Japan a specimen of which is placed on the wall.

Crustaceans and Insects

This group is second only to the arthropods in the vast number and

diversity of forms which it embraces, including marine, fresh water and land animals. All mollusks have soft bodies, but nearly all of them secrete a shell which in many species is of pearly material (mother-of-pearl). Well-known examples of this group are the common clam and oyster and enlarged models in the center case show the anatomy of these species. The largest species is the huge "bear's paw" or furbelowed clam of the eastern seas.

Alcove 11 Mollusks

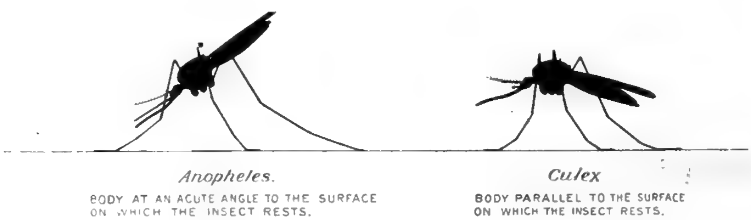
Model of Clam and Oyster

Vertebrates include the largest, most powerful and most intelligent of animals. The group culminates in man who still bears witness to his chordate ancestry in the retention of a chorda and gill clefts during embryonic life. The models in the central case show the development of the egg of typical vertebrates.

Alcove 12 Vertebrates

An exceptionally large specimen of beautiful madrepore coral is in the case near the entrance, and the associations of marine life that may be found among the coral reefs of the Bahamas are represented by several smaller groups in the center of the hall. Certain of the groups in this section of the hall illustrate various biological principles associated with the name of Darwin. The variation in form, size and color of the snail and the variation of the shell of the common scallop are graphically shown.

Coral

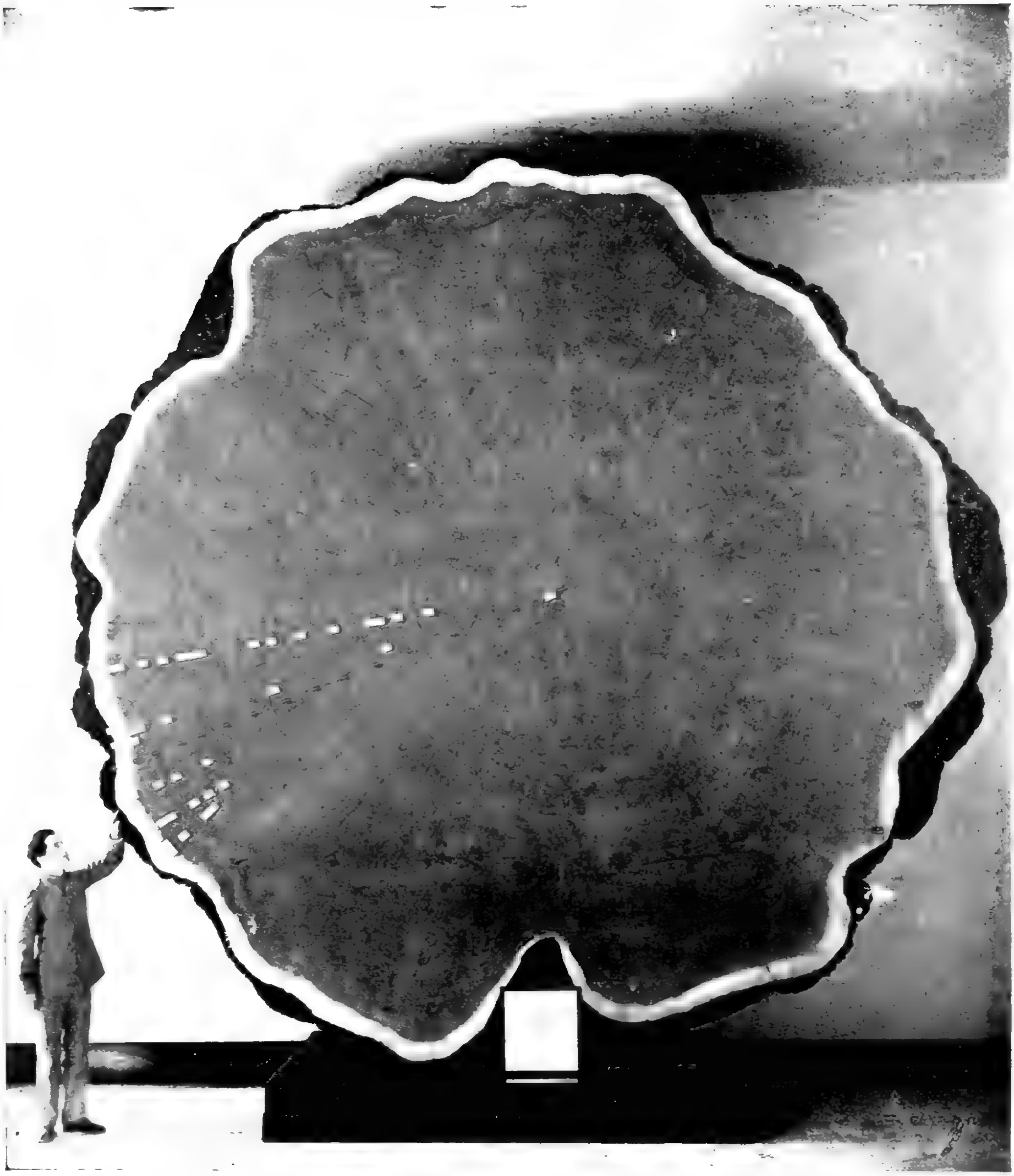


Characteristic resting positions of malarial and common mosquitoes

Four large models in the center of the hall show the mosquito which is the cause of the spread of malaria. These models represent the insect enlarged seventy-five diameters or in volume four hundred thousand times the natural size. The mosquito in its development undergoes a metamorphosis. The model at the left shows the aquatic larval stage; the larvæ are the "wrigglers" of our rain water barrels. The next model is the pupal stage, also aquatic. The third model is of the adult male mosquito which is harmless since it never bites man. The fourth model shows the adult female mosquito in the attitude of biting. In another case is a series of models showing the life cycle of the malarial germ in the blood of man and in the mosquito.

Models of the Malarial Mosquito

[*Return to the elevators.*]



THE "BIG TREE" OF CALIFORNIA

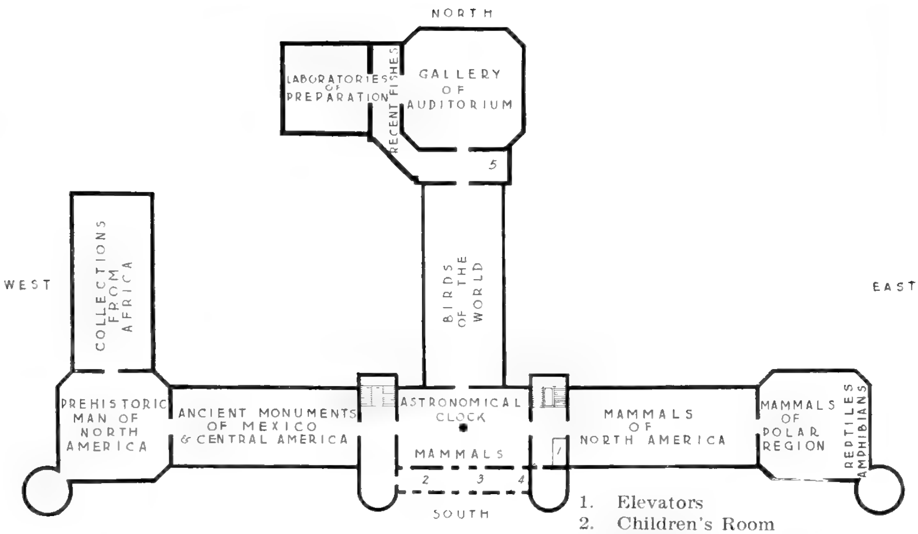
On the west wall of Darwin Hall are sections of the coast redwood and Big Tree of California. The tags on the latter indicate historical events that occurred during the life of the tree. [See *Guide Leaflet* No. 8]

This individual Big Tree which was 300 feet high grew for 1341 years, from 550 to 1891, when it was cut and brought to the Museum. It was nearly a thousand years old when Columbus came to America and more than a thousand when Harvey discovered the circulation of the blood

This largest, oldest, most majestic tree in the world exists only in ten small forests — groves they should almost be called — on the western slope of the Sierras. The trees are in large part under government control, so may continue to live through several generations of men

34 THE ASTRONOMICAL CLOCK

This exhibit makes clear the cause of day and night, of the differences of local time and of the succession of the seasons. A four-foot globe, standing for the earth, is regulated to rotate on its axis and to revolve around the sun. A strong beam from an electric stereopticon represents the light and heat from the sun



1. Elevators
2. Children's Room
3. Room for the Blind
4. Natural History Reading Room
5. Office of Department of Public Education

SECOND FLOOR

SOUTH PAVILION

Mammals

Astronomical Clock

Passing to the left from the elevator we enter the *South Pavilion* including the Mammals, and also in the center an astronomical clock. This is a model illustrating the movements of the earth and designed to tell the time of day. Full explanation is found on the label.

Dogs

The various breeds of domesticated dogs are shown in the case on the east wall. This collection illustrates the variations which a species may undergo in domestication. The dog has been the companion of man from the very earliest time, but he is believed to have been derived from several wild species. [His remains are found in the shell heaps of primitive man.] The case contains such divergent types as the tiny toy spaniel, which can easily lie in one's hand, and the powerful St. Bernard which has rescued many travelers in the Alps; the hairless dog of Mexico and the shaggy collie useful in tending sheep.

From this case passing to the right around the hall, we find the small carnivores including the weasels, ferrets, ermine, and the foxes and bears. The next case contains the members of the cat family — the lions, tigers,

leopards and wild cats. The specimen of the Barbary lion was presented alive to the New York Zoölogical Society by the daughter of Mr. Andrew Carnegie, and after its death was sent to the Museum. It is a good example of what can be done in mounting an animal by modern methods of taxidermy.

Barbary Lion "Hannibal"

In the cases on the north wall are mounted specimens of the American bison with skeletons near for comparison. The Asiatic elephant is the famous "Tip" which was brought to this country in 1881, and for seven years was one of the attractions of Forepaugh's circus. He was given to the City of New York by Mr. Forepaugh and lived in the Central Park Menagerie until 1894, when because of his treacherous disposition it was found necessary to kill him. He is said to have caused the death of several of his keepers, and was twenty-three years old when killed.

Elephant "Tip"

In a corridor to the left of the astronomical clock as we approach from the elevator are the Natural History Reading Room, the Children's Room and the Room for the Blind.

In the Natural History Reading Room are placed popular books on natural history and especially books descriptive of the collections in the exhibition halls. The visitor is invited to make use of these books. The main library consisting of more than 70,000 volumes on natural science, is on the fifth floor, open free to the public from 9 A. M. to 5 P. M. daily, except Sundays and holidays.

Natural History Reading Room

Children's Room

The Children's Room is designed to arouse interest in natural history and outdoor life. The room is open regularly on Wednesday and Saturday.

The Room for the Blind contains specimens of animals and of Indian implements which can easily be handled and therefore are suitable for examination by the blind. The labels are printed in raised type in both Braille and New York point.

Room for the Blind

BARBARY LION "HANNIBAL," A GIFT TO THE MUSEUM BY THE NEW YORK ZOÖLOGICAL SOCIETY

The skin was mounted over a manikin modeled from life by an animal sculptor

37.

HALL OF MEXICAN AND CENTRAL AMERICAN ARCHAEOLOGY

A collection comprising many casts of ancient stelæ, or monuments carved from volcanic stone and probably commemorating events in pre-Columbian times; also codices or chartlike books that later replaced the stelæ as records; casts of sacrificial stones; pottery and figures worked in clay; and many rich objects in jade, gold and copper

A room of the Mu-seum's Mexican res-taurant, an accurat[e] restoration of templ[e] ruins at Mitla

SOUTHWEST WING

Ancient Monuments of Mexico and Central America

Continuing west from the South Pavilion containing the astronomical clock, we pass through the *West Corridor* which is reserved for the exhibits of the Department of Anatomy and Physiology and the Department of Public Health and enter the *Southwest Wing* devoted chiefly to ancient monuments from Mexico and Central America.

From the entrance to the middle of the hall are collections from South America and Yucatan. The rear of the hall contains material from Mexico. The reproductions illustrate chiefly the sculpture of Mayan and Nahuatl cultures and are the gift of the Duke of Loubat. The material of the Mayan culture comprises plaster casts of the ancient stone monuments, or stelæ and altar stones, the stone and obsidian tools used to carve them, stone sculptures found in excavations and ruined buildings of the ancient city of Copan, and pottery of various designs. At the left of the entrance are two cases of pottery, jade and stone work from Costa Rica and Panama, evidently marking a lower type of civilization.

Stelæ

The casts of the large stone pillars are taken from the ancient stelæ, and which probably were erected as monuments and some of which are standing even to-day. Returning to the center of the hall and going back to the east entrance, we see reproductions of stelæ from Copan arranged in order from the oldest and crudest form to a

higher and finer type of carving, covering a space of time of two or three hundred years. This arrangement applies only to the row of casts on either side, not to the two large central models, nor to the side exhibits. The early stelæ of about 100 A. D. have hieroglyphs carved in very low relief and with sharp corners, while the hieroglyphs of the later period are cut deeper and in more rounded relief. In the earlier stelæ human figures are carved in a crude blocklike manner, with protruding eyes and angular limbs. Students of this subject have been able to decipher a large part of these hieroglyphs and figures which give dates and reckonings.

The monolithic monuments mark the first period of Mayan culture.

Altar Stone

The large altar stone to the left of the entrance is also of the first period and is perhaps the finest and most perfectly preserved specimen of which we have a reproduction. It represents a double-headed monster which had religious significance.

The second period of Mayan culture was more architectural in style and the art was a higher type, as is evidenced by the profile work in the reproductions of the carvings from the temples at Palenque shown on the north side of the hall. On the south wall another example of the art of this period is the copy of the painted sculpture from the "Temple of the Jaguars" at Chichen-Itza, Yucatan. It shows warriors in procession going to worship some god and their prayers are represented as coming from their lips. This sculpture shows strong evidence of Mexican influence in certain of its details.

Next in order is the Nahuatl culture, which is represented in the alcove cases by ancient pottery, musical instruments, copper objects, and ornaments made of obsidian and jade. The Nahua language was spoken by many of the tribes of Mexico and of these the Aztecs inhabited only the City of Mexico. One case contains facsimile reproductions of ancient

Codices

books called codices which were made of deerskin, paper or cloth. These were historical, religious or civil records and the Spanish burned hundreds of them in their efforts to destroy the native religion. The so-called sacrificial stone or the "Stone of Tizoc" has carved

Calendar Stone

around it records of Aztec conquests of various cities. The "Calendar Stone" on the south wall, was found in the City of Mexico and the original is now in the museum of that city.

Other culture areas in Mexico are shown by the names Tarascan, Zapotecan, etc. The Tarascan is situated mostly in the states of Michoacan

Funeral Urns

and Jalisco. The most interesting objects from this area are funeral urns which represent men and women in their everyday dress. The modeling is very peculiar. The Zapotecan culture area is situated in Southern Mexico and the most famous ruins are

Mitla and Monte Alban. A cruciform tomb at Guiaroo, near the ruins of Mitla, is shown by a model at this end of the room. The collection of goldwork in an adjoining case is very fine.

SOUTHWEST PAVILION

Prehistoric Man of North America

Continuing west we pass into the *Southwest Pavilion* likewise given over to archæology, in this instance that of North America. Here are examples of ancient pottery, arrow-heads, stone axes and other implements of stone and bone, mostly from burial mounds. Notice that the arrangement from left to right around the hall is by states. Read the label at the entrance of this hall. For more complete description read case labels and various books of information on the exhibits in this room. [See *Guide Leaflet* No. 2].

WEST WING

Collections from Africa

Opening to the north from this hall of North American Archæology is the hall devoted chiefly to African ethnology although temporarily African mammals also are installed here. The installation is geographical, i. e., as the visitor proceeds through the hall from south to north he meets the tribes that would be found in passing from south to north of Africa, and the west coast is represented along the west wall, the east coast along the east wall.

"Caliph"

The hippopotamus is the famous "Caliph," who lived for twenty years in the Central Park Zoo and died when he was forty years old. He was the largest hippopotamus ever recorded.

Congo Collections

The central portion of the hall is given over to the anthropology of the Congo, the collections being largely the gift of Leopold II of Belgium. The decorative frieze is designed to give an idea of the character of the country and again the arrangement of the panels is geographical. The window transparencies show scenes of the daily life of the people, the thatched houses in which they live, the games they play and the clothes they wear. The South African negro is essentially an agriculturist; both men and women plant and hoe. Maize, millet, rice, beans, sweet potatoes and pumpkins are among the products.

Hunting is no longer common, although among some of the tribes they set traps for leopards and lions and hunt the hippopotamus. In one tribe

fishing is accomplished by putting poison into the water to stupify the fish which are then gathered in the hands by hundreds.

These primitive people of the Congo display remarkable skill in working iron, as an examination of their weapons of war and of the chase will show. Wood-carving, weaving, and spinning are done by the men; pottery is made by the women. Musical instruments are numerous. An exhibition of bronze and brass castings, a craft among the Benin and unheard of before 1897, is in the north end of the hall. Many of these bronzes portray cultural traits. This method of casting was employed in Europe in the Renaissance period. How old the art may be and how much of it is really native is a question.

Bark cloth, shown in some of the cases, is used for bed mats and clothing. In the case at the south end of the Congo collections are a number of so-

MULANDI CARVED STICKS, AFRICA
Wood carving is a highly developed art in South-central Africa and the Congo. The carving on these knob-sticks represents great power of finish and execution

called "pile blankets" which the men weave and the women decorate.

The countless number of knives, spears and warlike implements is suggestive of the manner in which these people live; they are never certain of not being attacked. They make few permanent things and store up little food in time of plenty.

Fetish worship is common. Some of these fetishes are supposed to give security in battle or to ward off ills. The ceremonial masks of which a great number are on exhibition, are owned and worn mostly by the shamans or priests. Ancestor worship is found among some tribes.

[*Return to the astronomical clock.*]

SOUTH CENTRAL WING

Birds of the World

Going north from the hall of mammals past the case containing the lion "Hannibal," we enter the hall containing the general collection of birds of the world. In the first four cases on the right the 13,000 known species of birds are represented by typical examples of the principal groups arranged according to what is believed to be their natural relationship. The remaining cases on the right wall and all of those on the left show the geographical distribution of the bird fauna of the world. The specimens are grouped according to the great faunal regions — namely, the South American Temperate realm, American Tropical, North American Temperate, African, Indo-Malay and Australian realms. These cases in connection with the accompanying maps give opportunity for a comparative study of the birds of these regions.

Birds of the World

THE PTARMIGAN IN WINTER

One of a series of four small groups showing this bird's seasonal changes of color as brought about by molting and feather growth

In the middle of the hall are various cases showing characteristic scenes of bird life. A group of ptarmigan in seasonal plumage is at the entrance. Unlike most birds the ptarmigan has three distinct molts a year: From the pure white of winter it passes in the spring into the dark gray-brown plumage of summer. It again sheds its feathers in the fall, acquiring a plumage of lighter brown which harmonizes more nearly with its surroundings. Then later it passes into its winter plumage of white. Beyond the ptarmigan group is the great auk case and the Labrador duck group; both of these birds are now extinct, and there are only four mounted specimens of the former in this country.

Ptarmigan

Great Auk

Labrador Duck

In a case near the center of the hall is an exhibit illustrating the differences in structure of the beaks and claws of birds, and some of the habits of various species of North American woodpeckers.

At the north end of the hall is a nearly complete collection of the birds of paradise of the world, presented by Mrs. Frank K. Sturgis. Birds of paradise are confined exclusively to New Guinea and a few adjacent islands. This collection illustrates the remarkable modifications that the feathers of a single group of birds may undergo in nature.

Birds of Paradise

Finback Whale

Suspended from the ceiling of this hall is the skeleton of a finback whale, sixty-two feet in length.

CORRIDOR OF CENTRAL PAVILION

Recent Fishes

The doorway at the north end of the hall of the birds of the world leading to the rear of the bird of paradise case opens into the gallery of the *Auditorium* and to the corridor devoted to the general collection of recent fishes. This hall contains representatives of the marine and fresh-water fishes of the world. The exhibit includes typical examples of the various groups of vertebrates popularly comprised in the term "fishes" and is arranged to show first the most primitive fishes, the sharks, then successively various groups leading up to the teleosts or bony fishes, which were the last to appear in the course of evolution. These groups are as follows: lampreys and hagfishes, eel-like creatures with round sucking mouths and no jaws, hence not really fishes in the strict sense of the word; sharks and rays, the most primitive, that is the most ancient type of fishes; chimæroids or rat-fishes, a group of highly modified sharks living mostly in the deep sea; lungfishes, an ancient group represented at the present time by three kinds or genera, living respectively in the rivers of Australia,

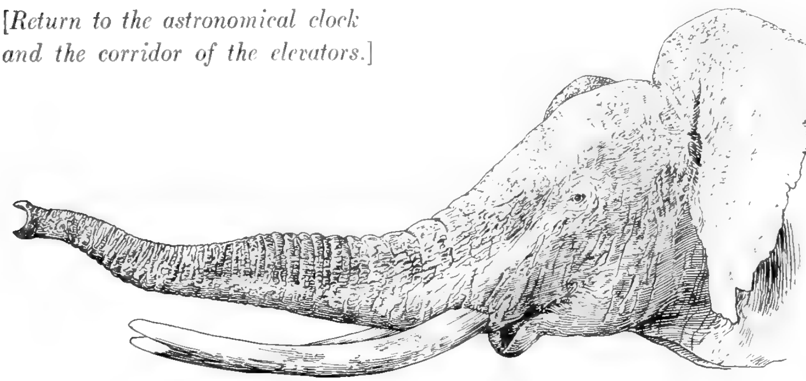
Fishes

Africa and South America; ganoids, including the sturgeon, gar pike, paddlefish, bowfin and the African bichirs. In earlier geological ages ganoids were more numerous than other fishes, but at present they are few and relatively unimportant.

The teleosts or bony fishes comprise about 10,500 species, or nearly nine-tenths of all existing forms, including the majority of food and game fishes, such as the bass, carp, cod, eel and herring.

An exhibit of fossil fishes is to be found on the fourth floor.

[Return to the astronomical clock and the corridor of the elevators.]



SOUTHEAST WING

Mammals of North America

Continuing east beyond the elevator corridor, we enter the hall containing specimens of North American mammals. In the cases on the west wall are several groups illustrating the mammals found within fifty miles of New York City. The first of these groups shows the opossum, the sole representative in the United States of the marsupial or pouched mammal. With what appear to be the head and ears of a pig and the prehensile tail of a monkey, with a strange pouch for the transportation of the young, and with proverbial cunning and remarkable tenacity of life, the opossum is one of the quaintest and most interesting of North American mammals. This is the animal so famous in the negro songs of the South.

Opossum

Next in order is the raccoon, more commonly known as the "coon." It is nocturnal in habit and makes its nest in hollow trees. Two species of fox are shown, the red fox and the gray fox, both of which are justly famous for their sly cunning.

Raccoon

Foxes

Skunk

The common skunk is a very useful although greatly abused animal. While it occasionally destroys poultry and other birds, its principal food consists of injurious insects and field mice. Its defensive weapon is an excessively fetid fluid secreted by a pair of glands situated near the base of the tail. It has the ability to eject this fluid to a

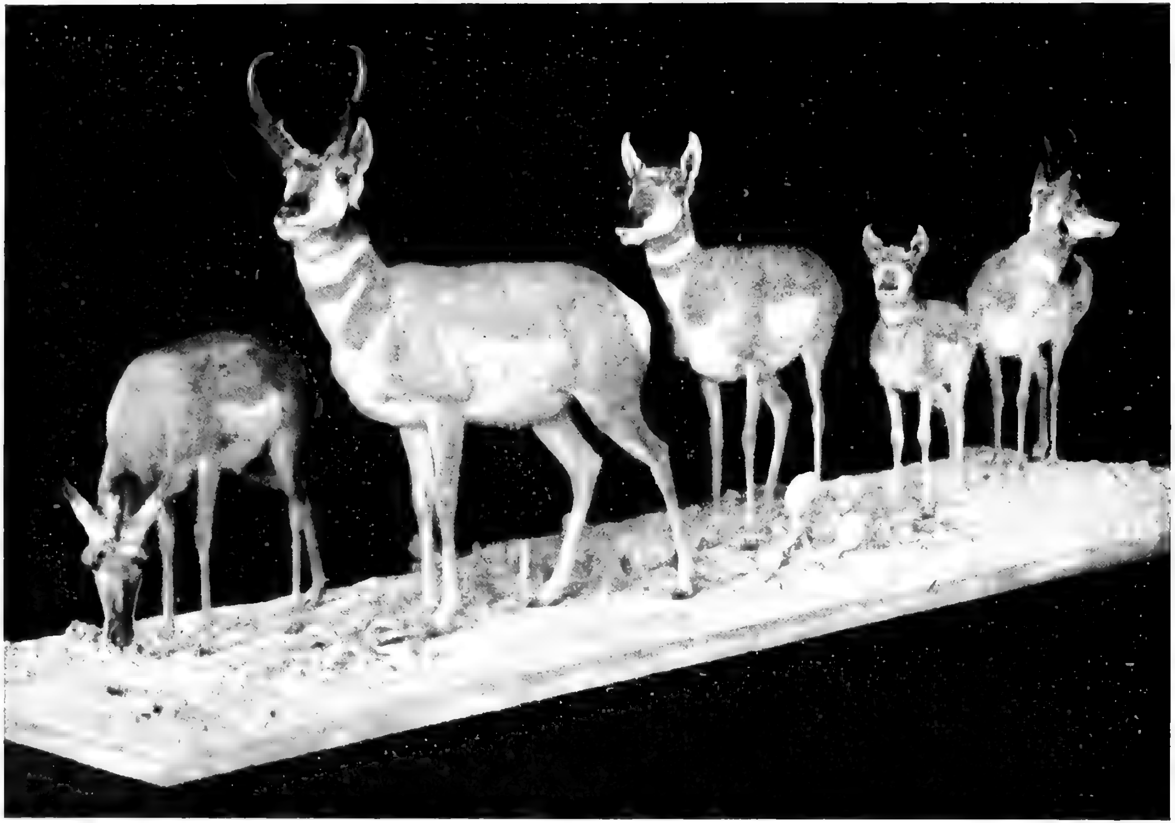
THE WEASEL GROUP

One of the groups representing the small mammals found within fifty miles of New York City. The others of the series show opossum, raccoon, red and gray foxes, skunk, mink, muskrat, woodchuck, rabbits and squirrels. The list includes some "fur-bearing" species; weasel fur is often used instead of ermine.

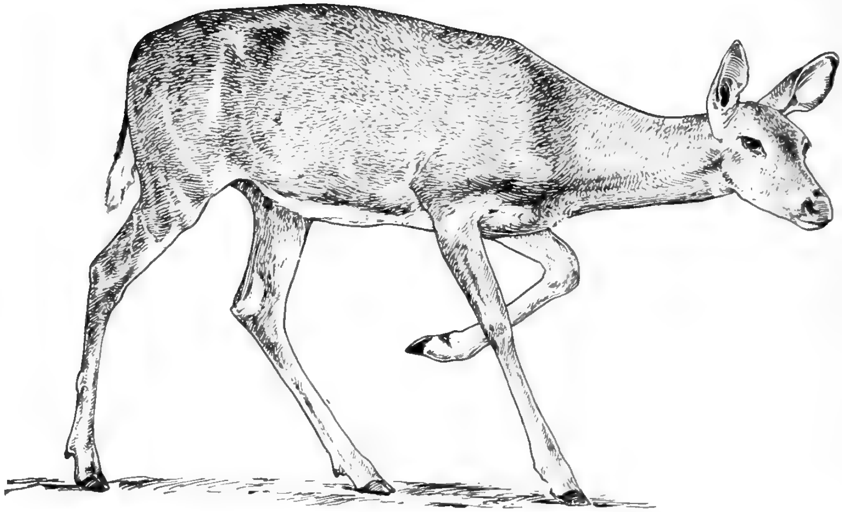
considerable distance. Its skin makes a valuable fur known as "Alaskan sable."

Mink and Weasel

Two other fur-bearing animals shown are the mink and the weasel, the latter in both its summer dress of dull brown and its winter coat of white. Weasel fur is often used in place of ermine.



A GROUP OF ANTELOPE SHOWING THE MANNER IN WHICH THEY WANDER ACROSS THE PLAINS



THE VIRGINIA DEER

Line drawing from the mounted specimen. This Virginia doe stands as the first example in the Museum of the new methods of animal sculpture as opposed to the old taxidermy

Muskrat

Another fur-bearing animal shown is the muskrat. In the group are seen its summer home, usually a burrow in the bank of a stream or pond, and its winter mound, constructed of swamp grass and roots mixed with mud. Muskrats are extensively trapped for their fur.

Woodchuck

The woodchuck or ground hog is a vegetable feeder but does very little harm to crops. It hibernates for a large part of the year usually from September to April. The old legend says that the ground hog comes out of his hole on the second of February and if it is bright and he sees his shadow, he goes back into his hole for six weeks longer and we may expect more cold weather.

Hares and Squirrels

Other groups represent the varying hare and the common species of squirrels.

Moose Group

In the central section of the hall is a group of moose. It represents an early autumn scene in a secondgrowth forest in New Brunswick, and illustrates one of the favorite feeding grounds of the moose. Beyond the moose exhibit are species of mammals found within fifty miles of New York City, namely Virginia deer, the otter and the wild cat or lynx.

Bison Group

The buffalo group gives a typical bit of the prairie traversed by buffalo trails, while the members of the herd represent different stages of growth of the buffalo. This is the animal which formerly roamed in countless numbers over the western plains but which is now reduced to a few insignificant herds.

Antelope Group

On the south side of the hall are displayed the cloven-hoofed animals of North America. These include sheep, musk ox, caribou, collared peccary and various species of deer. At the extreme end of the hall is a group of antelope showing the manner in which they wander across the plains. This animal possesses the power to raise or lower at will the long hairs on the rump in such a manner that the light is reflected as from a mirror, and by this flashing the animal is said to signal approaching danger. On the north side of the hall are shown the rodents and carnivores. [See *Guide Leaflet* No. 5.]

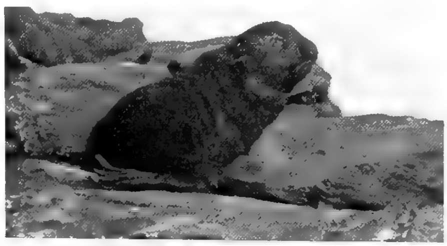
SOUTHEAST PAVILION

1. Mammals of the Polar Region

2. Reptiles and Amphibians

Fur Seal Group

Proceeding eastward beyond the antelope group we enter the *Southeast Pavilion* containing the boreal animals of North America and at the extreme east of the hall the exhibit of reptiles and amphibians. At the entrance is shown a family of fur seals as it appears in one of the seal rookeries in the Pribilof Islands. During the breeding season the fur seals, from which is obtained the sealskin of commerce, congregate in their island rookeries in great numbers and have been so hunted by man that they are threatened with extinction.



A YOUNG SEAL OF THE FUR SEAL GROUP

Grant's Caribou Group

Grant's caribou inhabit the barren ground of the extreme western end of the Alaskan peninsula. The type specimen of this species is in the Museum.

Mountain Sheep Group

The mountain sheep inhabit the more inaccessible mountain regions of the West from the northern part of Mexico to the shores of the Arctic ocean. It is probable that they originated in the mountains of Central Asia and spread through Siberia into the American continent. The geographic variation of the mountain sheep of North America is shown on the section of a globe near the group. [See *Guide Leaflet* No. 5.]

A POLAR BEAR SECURED FOR THE MUSEUM BY ADMIRAL PEARY

At the right is a large wall case group of the Atlantic walrus. These

Walrus Group

huge mammals are relatives of the seals, inhabit the waters of the far north and are still fairly abundant along the shores of Greenland. The seal and walrus are the animals which play such an important part in the life of the Eskimo. From these animals come the principal food supply, skins for clothing, for fishing and hunting gear, boat covers, and harnesses for dog teams; from bones and tusks are made knives, bows, harpoons, and other hunting and cooking utensils.

Polar Bear

The polar bear and cubs were secured for the Museum by Admiral Peary.

The Roosevelt elk or wapiti inhabits the Coast Range of mountains from

Roosevelt Elk

British Columbia to northern California. These animals are nearing the verge of extinction through indescribable slaughter although formerly very abundant.

The specimens in the musk ox group were collected for the Museum

Peary Musk ox Group

by Admiral Peary in 1896. Musk oxen inhabit the snow-covered wastes of the Arctic barrens, living upon willow leaves, lichen and bark dug up from under the snow.

The collection of reptiles and amphibians is exhibited at the east side

Reptiles and Amphibians

of this hall and in the adjoining tower room. Because of the difficulty of preserving the natural covering of many of these animals they are usually exhibited in jars of alcohol. In the specimens on exhibition here the perishable parts have been cast in wax from life; for example in the star tortoise the original "shells" of the specimens are used, while the head, neck and legs are restored in wax.

The classification of these animals is shown in the tall cases along the west side of the alcove, the case to the right of the entrance being devoted to the amphibians; the others to lizards, snakes, turtles and crocodiles. The mounting not only brings out the principal features of the species exhibited, but in many instances illustrates also some distinctive habit of the animals; for instance the common newt, one of the salamanders, is represented by a series of five life-size casts showing the process of shedding the skin; Pickering's hyla or the "spring peeper" is shown with vocal sacs inflated; the poisonous bushmaster is represented with its eggs, and so on.

The groups in the center of the hall represent various reptiles as they appear in their natural haunts. They include the tuberculated iguana, the water moccasin, the diamond-backed rattlesnake; the Texas rattlesnake, the copperhead, the Gila monster, the pine snake, the box tortoise and the common painted turtle.

One of the most interesting of the groups is a jungle scene in India show-

A PORTION OF THE BULLFROG GROUP

Two frogs are engrossed in a chickadee on the birch branch above. The smaller frog seems likely to fall a prey to a black snake ready to strike from the white azalea near

The scene is typical of southern New England in July. The frogs and the reptiles are wax casts from life The various activities of bullfrog life are set forth, with the relations to birds and small mammals, fish, snakes, turtles, insects and snails. The metamorphosis from the tadpole is also shown

ing a water monitor, which is the largest of living lizards, the poisonous Russell's viper and the deadly spectacled cobra, the last with hood distended and poised ready to strike. The cobra is said to be the cause of a great majority of the 20,000 deaths which annually occur in India from snake bite. Examine carefully the group of the copperhead snake or "red-eye," one of the two species of poisonous snakes to be found in the vicinity of New York and also the group contrasting the harmless water snake with the poisonous water moccasin of southern cypress swamps. Two groups are devoted to rattlesnakes, which are easily recognized by the string of rattles at the end of the tail, by means of which they give warning before they strike. There are comparatively few species of poisonous snakes in the United States, about sixteen in all, comprising rattlesnakes, the moccasin, copperhead and two kinds of coral snake. All other species are harmless and in spite of the almost universal prejudice against them are a very useful ally of man since they live chiefly on rats, mice and insects injurious to crops.

Cobra Group

Copperhead Snake Group

The bullfrog's tongue is fastened in front and the free hinder end can be thrown far out of the mouth to capture insects

Bullfrog Group

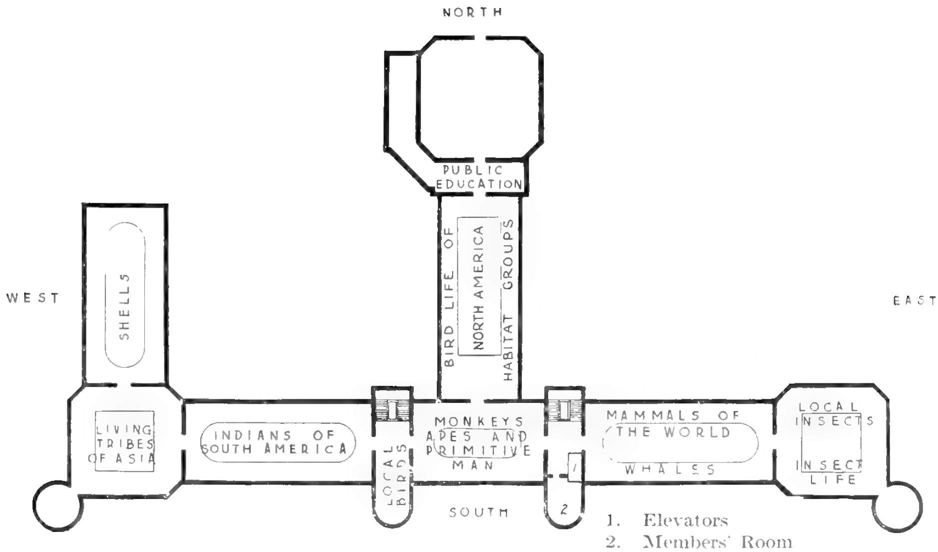
Entering the darkened tower room we find a group of unusual interest, showing the common bullfrog of North America.

This group is a study of the bullfrog undisturbed in its typical haunt. It illustrates the changes from the tadpole to the adult frog and shows many of the activities of the frog — its molting, swimming, breathing under water and in air, croaking, and "lying low" before an enemy; also its food habits in relation to small mammals, to birds, snakes, insects, snails, to small fish and turtles.

[*Return to the elevators.*]

A DETAIL OF THE FLAMINGO GROUP

Neither "protective coloration" nor "cover" can be said to help in the preservation of this species, for the flaming creatures live on bare islands in colonies thousands strong. Their protection lies in their isolation, their shyness and the open character of the haunt which allows them to see long distances



THIRD FLOOR

SOUTH PAVILION

1. Monkeys, Apes and Primitive Man
2. Rodents

Monkeys and Apes

The primates, the monkeys and apes of the world, occupy the *South Pavilion* of the third floor, the first hall at the left as one turns from the elevators. These animals in structure and brain capacity resemble man more closely than do any other of the mammals, but while man and the apes have sprung from a common ancestor, in no sense has man descended from the existing apes.

Orang-utan Group

A family of orang-utans, the most powerful and most ferocious of the apes, is shown in a case on the south side of the hall. In another case the skeleton of a chimpanzee, "Mr. Crowley," and of a gorilla are placed beside a skeleton of a man to allow a study of the similarities in structure.

Rodents

On the other side of the hall will be found the bats, the only mammals that really fly, and the hares and other rodents, among which the rat, mice and squirrels are familiar examples. The rodents are the most numerous and the most widely distributed of the mammals.

Suspended from the ceiling in the center of the hall is a skeleton of a North Atlantic right whale which is more than forty feet in length. The

A FLAMINGO COLONY IN THE BAHAMAS

A "city" of these birds is the most remarkable sight in the world of birds. The mud nests are raised eight to fourteen inches and thus protected during rise of water

DUCK HAWK ON PALISADES OF THE HUDSON

Realism and artistic effect have been achieved in the "Habitat Bird Groups," and they present vividly many stories of adaptation to environment

hall also contains small groups showing the nesting habits of a number of our common birds, among them the phalarope, oriole, flycatcher, robin, tanager, vireo and quail.

SOUTH CENTRAL WING

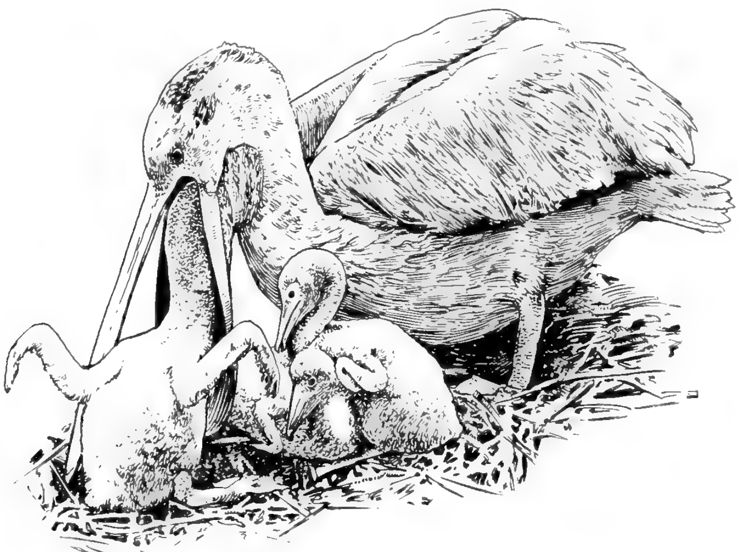
Bird Groups

Here are the "Habitat Groups" of North American Birds. This unique series of groups shows the habits of some typical American birds in their natural haunts. The groups have been prepared under the immediate direction of Frank M. Chapman, Curator of Ornithology, who collected most of the specimens and made practically all of the field studies necessary for their reproduction. In the course of this collecting, he traveled more than 60,000 miles. The backgrounds are reproductions of specific localities, painted from sketches made by the artist who usually accompanied the naturalist when the field studies for the groups were made. Practically all sections of the country are represented, thus the series not only depicts characteristic bird life of North America but characteristic American

scenery as well. The backgrounds of the groups were painted by Bruce Horsfall, Charles J. Hittell, J. Hobart Nichols, Carl Rungius, W. B. Cox and Louis A. Fuertes. The artificial foliage and flowers were made in the Museum laboratories from material collected in the localities represented. Each group is fully described in the label attached to the case. See also *Guide Leaflets* No. 28, No. 1 and No. 22. Beginning with the case at the right of the entrance and passing on to the right around the hall, we find the groups arranged in the following sequence:

Orizaba Group

The distribution of birds, notwithstanding their powers of flight, is limited in great measure by climate. Thus in traveling from Panama north to Greenland there are zones of bird life corresponding to the zones of temperature. This condition is illustrated in the mountain of Orizaba in Mexico, where in traveling from the tropical jungle at its base to its snow clad peak the naturalist finds

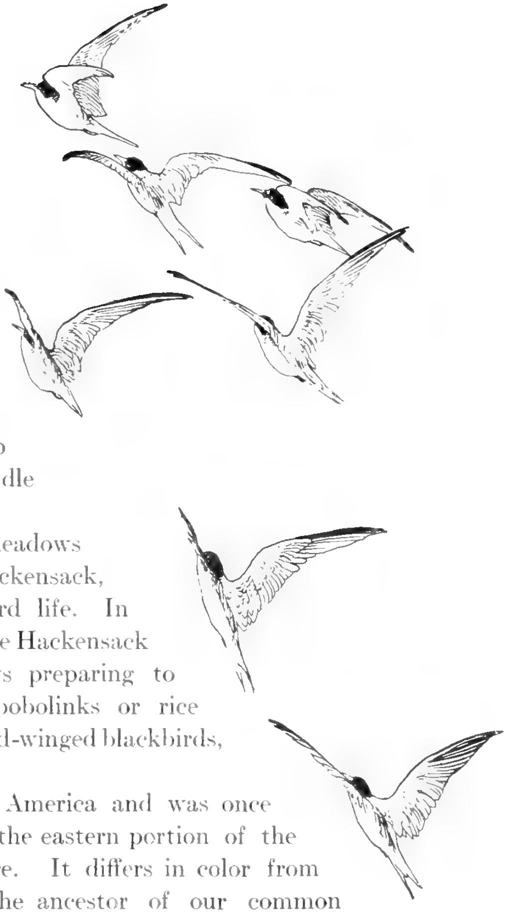


White pelican from Klamath Lake Group, Oregon. One young bird is illustrating its amusing method of procuring food from its parent's throat

zones of life comparable with those to be found in traveling north on the continent. Thus the Orizaba group so far as the distribution of life is concerned is an epitome of all the groups in the hall.

Cobb's Island Group

Among our most beautiful and graceful shore birds are the terns and gulls, which (because of their plumage) have been so ceaselessly hunted and slaughtered for millinery purposes that now in their breeding places there are only hundreds where formerly there were thousands. The group represents a section of an island



Terns
Cobb's Island Group

off the Virginia coast where the birds are now protected by law.

Duck Hawk Group

The duck hawk may be found nesting on the Palisades of the Hudson almost within the limits of New York City. It builds nests on the ledges of the towering cliffs. This hawk is a near relative of the falcon which was so much used for hunting in the Middle Ages.

Hackensack Meadow Group

In August and September the meadows and marshlands in the vicinity of Hackensack, New Jersey, are teeming with bird life. In the group showing these Hackensack meadows are swallows preparing to migrate southward, bobolinks or rice birds in fall plumage, red-winged blackbirds, rails and the wood duck.

Wild Turkey Group

The wild turkey is a native of America and was once abundant in the wooded regions of the eastern portion of the United States, but is now very rare. It differs in color from the Mexican bird, the ancestor of our common barnyard turkey, which was introduced from Mexico into Europe about 1530 and was brought by the colonists to America. (Reproduced from studies near Slaty Forks, West Virginia.)

Florida Great Blue Heron Group

The great blue heron usually nests in trees. The bird flies with its neck curved back on its body and because of this habit can readily be distinguished from the crane with which it is frequently confounded. (Reproduced from studies near St. Lucie, Florida.)

Water Turkey or "Snake-bird" Group

In the "bonnets" or yellow pond lily swamps with cypresses and cabbage palmettoes, the shy water turkey builds its nest. It receives the name "turkey" from its turkey-like tail and the title "snake-bird" from its habit of swimming with only the long slender neck above water. (Reproduced from studies near St. Lucie, Florida.)

Sandhill Crane Group

The sandhill crane builds its nest of reeds in the water. Unlike the herons in this respect, it differs also in its manner of flight, always stretching its neck well out when on the wing. (Reproduced from studies on the Kissimmee Prairies of Florida.)

AMERICAN EGRET IN A SOUTH CAROLINA CYPRESS SWAMP

Egrets are well-nigh exterminated by plume-hunters. The birds carry the plumes only during the nesting season, therefore destruction of the parents means the starvation of the young birds in the nest

Brown Pelican Group

Pelican Island on the Indian River of Florida has been made a reservation by the United States Government, and these grotesque birds may now breed there undisturbed. The view shows a section of the island at the height of the nesting season. Notwithstanding the hundreds of young birds that are clamoring for food, observation has shown that the parent bird can pick out its own offspring with unfailing accuracy. (Reproduced from studies at Pelican Island, Florida.)

Snowy Heron or Egret Group

This beautiful bird has been brought to the verge of extinction in this country through the use of its "aigrette plumes" for millinery purposes, and is now confined to a few protected rookeries of the South. The birds have these plumes only during the nesting season, at which time the death of the parent means the starvation of the young. (Reproduced from studies in a rookery of South Carolina.)

Turkey Vulture Group

The turkey vulture or buzzard is one of the best known birds of the South where it performs a valuable service in acting as the scavenger of the streets. On this account it is protected by law and by public sentiment and has become both abundant and tame. (Reproduced from studies at Plummer Island in the Potomac River, near Washington.

California Condor Group

The California condor is the largest and one of the rarest of North American birds. It is not so heavy as the condor of the Andes but has a slightly greater spread of wing, eight and one-half to eleven feet. In the group the visitor is supposed to be standing in the interior of the cave where the bird has its nest and is looking down on the river of the cañon which is more than five thousand feet below. (Reproduced from studies in Piru Cañon, California.)

Brandt's Cormorant Group

The foreground of the group shows a detail of the island that is painted in the background. The young birds are feeding and it will be noticed that one fledgeling is reaching well down the mother's throat after the predigested food. (Reproduced from studies at Monterey, California.)

San Joaquin Valley Group

Formerly this area was an arid place with a characteristic desert bird fauna. Now the ranchmen have irrigated the land and aquatic bird life abounds. This group is a good illustration of the influence of man on the bird life of a region.

In the breeding season the flamingos congregate in great numbers in their rookeries. There were estimated to be two thousand nests in this colony. The flamingos construct their nests by scooping up mud with

Flamingo Group their bills and packing it down by means of bills and feet. The nests are raised to a height of twelve or fourteen inches; this protects eggs and young from disasters due to high water. Only one egg is laid in the nest, and the young is born covered with down like a young duck and is fed by the mother on predigested food. The brilliant plumage of the adult is not acquired until the fifth or sixth month. (Reproduced from studies in the Bahama Islands.)

Booby and Man-of-War Group In this group is shown a portion of a coral islet on which three thousand boobies and four hundred man-of-war birds were nesting, the former on the ground, the latter in the sea grape bushes. (Reproduced from studies in the Bahama Islands.)

The abundance of bird life in one of these rookeries is quite astounding.

Florida Rookery Group In this group are roseate spoonbills, snowy egrets, American egrets, little blue herons, Louisiana herons, ibises, cormorants and water turkeys. Because of the great inaccessibility of this island it has been one of the last places to escape the depredations of the plume-hunter. (Reproduced from studies in the Everglades of Florida.)

Golden Eagle Group The golden eagle is one of the most widely distributed of birds. In North America it is now most common in the region from the Rockies to the Pacific coast, although it is found as far east as Maine. Stories to the contrary notwithstanding, the eagle never attacks man even though the nest is approached. Its food consists of rabbits, squirrels, woodchucks and occasionally sheep. (Reproduced from studies near Bates Hole, Wyoming.)

Klamath Lake Group The abundance of bird life in this western lake beneath Mt. Shasta, which is seen in the center of the background, is astonishing. Here is an example of how the normal nesting habits of a bird may be changed by its being driven into a different locality. In the group are white pelicans which usually make a nest of pebbles, Caspian terns which commonly build their nests on sand, and cormorants that nest on rocks, all nesting together here on the tule or rush islets of the lake. (Reproduced from studies at Klamath Lake, Oregon.)

Arctic-Alpine Bird Life Group The scene represented in this group is above timber line on the crest of the Canadian Rockies — 8,000 feet above the sea. Although these mountains are in the temperate region the altitude gives climatic conditions that would be found in the far north, and the bird life is arctic in character. Here are nesting the white-tailed ptarmigan, rosy snow finches and pipits. (Reproduced from studies in the Canadian Rockies.)

A grebe swims in stately fashion, while, peeping from the warm cradle of her back, eager, contented young birds take a sail with her

Sage Grouse Group

This group shows a stretch of western plateau covered with sage bush. In this bush is seen the male sage grouse strutting and wooing a mate. (Reproduced from studies at Medicine Bow, Wyoming.

Prairie Chicken Group

The prairie chickens are akin to the common grouse. The group represents a typical scene during the mating season. The male birds go through most surprising antics in their efforts to attract the females. They inflate the orange-colored sacs on the sides of their necks, dancing and strutting about and uttering a loud resonant booming note. (Reproduced from studies near Halsey, Nebraska.)

Wild Goose Group

The wild goose is one of the first birds to migrate north in the spring. It nests in the lakes of Canada even before the ice is melted. To secure the young birds for this group it was necessary to hatch the eggs of the wild goose under a hen, so difficult is it to find the young in nature. (Reproduced from studies made at Crane Lake, Saskatchewan, Canada.)

Grebe Group

The grebe is another of our aquatic birds which builds its nest near the water. During the incubation period the parent bird usually covers the eggs with grass and reeds when leaving the nest. Nesting at the same lake with the grebe was the red-head duck, which lays from fifteen to twenty eggs. (Reproduced from studies made at Crane Lake, Saskatchewan, Canada.)

Loon Group

The loon is justly famed for its skill as a diver, and can swim with great speed under water. Its weird call is a

Love making of the prairie chicken. In this position and with orange-like air sacks inflated, he produces a booming sound which may carry a distance of two miles

familiar sound on the northern New England lakes. Many loons pass the winter at sea fifty miles or more from land. (Reproduced from studies at Lake Umbagog, New Hampshire.)

Bird Rock Group

This rocky island thirty miles from shore in the Gulf of St. Lawrence affords some protection to the sea birds which still nest in great numbers on and in its cliffs, although the colony is a mere shadow of what it was even fifty years ago. Seven species are shown nesting in the group. Namely the razor-billed auk, petrel, gannet, puffin, Kittiwake gull, common murre and Brünnich's murre. (Reproduced from studies at Bird Rock, Gulf of St. Lawrence.) [A description of the Bird Rock Group is given in *Guide Leaflet* No. 1.]

[*Return to the South Pavilion containing the apes and monkeys.*]

WEST CORRIDOR

Local Birds

Seasonal Collection of Birds

Returning to the South Pavilion where the monkeys are and passing to the right, we enter the *West Corridor* containing the collection of local birds. At the south end of the corridor are several cases in which the birds are changed each month to represent the bird life of the parks of the city. This exhibit is particularly useful for teachers and to those desiring to identify the birds which they see out of doors. Other exhibits which will appeal to the bird student are those showing types of feet, bill, wings and feathers. Variation of a species, that all important factor of evolution, is here illustrated in the geographical variation in size and color of the song sparrow. [See *Guide Leaflet* No. 22.]

Bird Feeding Group

The group near the stairway showing the feeding habits of birds, emphasizes the remarkable manner in which the bill of the bird is adapted to secure food. For instance the humming bird which feeds to a considerable extent on the nectar of flowers, has a long, slender bill; the birds of prey like the owl or hawk, have short, curved bills for fearing flesh; the seed-eating birds like the parrot, have thick, heavy bills, while the water-feeding birds like the duck, have broad, spoon-shaped bills.

Audubonaiana

The collection of Audubonaiana, or objects relating to the life and work of John J. Audubon, occupies the stairway wall. It comprises original sketches and drawings of Audubon and his sons and was presented to the Museum by his granddaughters.

SOUTHWEST WING

Indians of South America

Passing through the west corridor of local birds and on into the adjoining hall to the west, we find the collections relating to the Indians of South America. The greater part of the hall is filled with material from Peru, Bolivia, Ecuador and Chile, illustrating the various forms of culture that prevailed in the empire of the Incas. These Indians, together with the Mexican Indians,

Indians of South America

PIECES OF CLOTH FOUND WITH PERUVIAN MUMMIES

The only sources of knowledge of prehistoric Peruvians come from their graves. They were familiar with most modern weaves including the finest gobelins and produced highly decorative effects by harmonized colors and a repetition of woven-in designs. The Museum's collection of mummy cloths is perhaps the largest in the world, and is not fully known, for a large number of the mummy bundles have never been opened

TREPHINED SKULLS FROM PERUVIAN GRAVES, INDICATING A PREHISTORIC PRACTICE OF SURGICAL OR SACRIFICIAL OPERATIONS

attained the highest type of civilization on this continent in prehistoric times. Unlike the Mexicans however, they had no written language. They were tillers of the soil and raised maize, potatoes, beans, coca and cotton. The Incas domesticated the llama, which was used as a beast of burden. They excelled in the manufacture and decoration of pottery vessels, in metalwork, and in textile fabrics. In the case directly in front of the entrance are displayed gold and silver objects such as beads, cups, pins and earrings which show the skill of the Incas in the beating, soldering and casting of metals. In weaving they were perhaps preëminent among prehistoric peoples, many of their specimens exhibited here being unsurpassed at the present day. The materials used were cotton and the wool of the llama, alpaca and vicuña. In the first cases on the right are examples of these textiles with looms and shuttles. [The musical instruments of ancient Peru are discussed in *Guide Leaflet* No. 11.]

Gold and Silver

Textiles

The alcove cases are geographically arranged, showing exhibits from the north toward the south of South America, then up into the interior of the continent. The two-spouted drinking cups, copperwork, slings such as are still in use, portrait jars, vessels upon which the decorations represent fruit and vegetables and scenes from daily life, and black pottery, are all prehistoric and a number of the specimens are of rare beauty as well as valuable from an archæological standpoint.

The collections in the gallery rail cases include *quipos* used to keep accounts, various kinds of corn which with the lima bean and potato have been introduced into our country from Peru; charms and medicines, coca which was chewed, and maize which was used to make the national drink *chicha*. A number of the chicha jars are on exhibition on top of the wall cases at the east end of the room.

Chilean Mummy

The mummy in the case at the west end of the room was found at Chuquicamata, Chile, and is the body of an Indian which has been remarkably preserved by nature. This Indian may have met his death by the caving in of some mine, and in the dry climate of the region the tissues of the body have been so thoroughly impregnated with copper salts that the original form of the man is retained.

Trephined Skulls

On the north side of the wall are the ethnological collections from Brazil, British Guiana, Paraguay and Colombia. War implements, basketry, featherwork and musical instruments are arranged in these cases. One case contains skulls which evidence most extraordinary skill in trephining. For ritualistic purposes or for cures or for some other unknown reason, this supposedly modern surgical operation was successfully performed. Many of the tribes deformed their

skulls, this undoubtedly being considered a mark of beauty. It necessitated the binding of the head in infancy.

Mummy Bundles

The wall case at the left of the entrance contains mummy bundles, showing the burial customs of the Peruvians. In no part of America are found so many and so extensive burial places as in the coast region of Peru. Here were interred countless thousands of the ancient dead. In the *huacos* or graves, with the bodies, were placed such articles as had been most useful and highly prized during life, and such it was considered would be most serviceable in a future life.

PERUVIAN MUMMY BUNDLES AND MUMMY

The ancient Peruvians wrapped their dead in fabrics of fine linen and wool, then covering with a sack of strong cloth. The mummy "bundle" thus produced was often given a "false head" of cloth filled with vegetable fibre. Climatic conditions in Peru have preserved these mummies and their wrappings during many centuries

To this custom we are indebted for no small part of our knowledge of the daily life of the ancient Peruvians. From the mummy bundles and graves all the objects in the extensive collections in this hall, illustrating the civilization of the Incas, have been obtained. The wonderful state of

preservation shown in the textile fabrics and other perishable materials from the coast regions is due to the extreme dryness of the climate and the nitrous character of the soil. [See *Guide Leaflet* No. 24.]

SOUTHWEST PAVILION

Chinese and Siberian Collections

Collections from Asia

If we pass on into the hall at the extreme west end of the building, we find specimens showing collections from Asia. The arrangement is geographical. Read carefully the label at the entrance to the hall. Specimens illustrating the culture, industries, religion and manufactures of China are on the left; others showing the mode of living, the costumes and the war implements of Siberia are on the right. Bamboo, porcelain, basketry, inlaid work, cloisonne enamel, agricultural implements, carvings in wood, ivory and stone, and embroidery are shown to advantage. The furwork, costumes and rugs of the people of East Siberia reveal remarkable skill in workmanship. Two models show respectively summer and winter scenes in Siberia. A small model in one of the cases to the left shows the manner of making pottery. A series of frames in the rear contain pieces of various kinds of fabrics and patterns illustrating weaving and woodwork ornaments.

WEST WING

Shells

The collection of shells is being installed in the *West Wing* and is not yet open to exhibition. It contains altogether about 100,000 specimens representatives of nearly 15,000 species. These show extraordinary range of color and ornamentation. The arrangement of the collection is still incomplete but the installation will be as follows: first, in the south wall cases will be placed a series showing briefly the classification of mollusks; second, in the eight table cases at the north and south ends of the hall the collections of land shells; third, in the upright railing cases the bivalves or mollusks which have two shells like the common clam; fourth, in the metallic cases the univalves, mollusks which have only one valve or shell like the snails; fifth, special exhibits of shells in the north wall cases. Other cases will contain exhibits illustrating the anatomy and habits of mollusks; colored transparencies will show them in their habitats.

[*Return to the South Pavilion containing the apes and monkeys.*]

SOUTHEAST WING

Mammals of the World

Continuing east from the hall where are the apes and monkeys, we pass the elevators, to enter the hall of the *Southeast Wing*, devoted mainly to mammals of the world. The exhibits read like the pages of a book from left to right, being arranged to bring out the phylogeny or past history and development of the chief divisions of mammals. The specimens are arranged not on shelves but close against the background of the case on small projecting supports and from each a cord has been stretched down along the background to a diagrammatic representation of the geological periods. In this way are indicated the relationships of the various animals to one another as well as the geological age in which each animal probably originated. Circling the hall above the cases is a mural frieze representing marine scenes, which serves as a background for groups of porpoises, dolphins and other small members of the whale family. The most striking object in the hall is the life-size model of a sulphur-bottom whale, seventy-nine feet in length. The original of this specimen was captured in Newfoundland and the model is accurately reproduced from careful measurements. As can be seen by examining the models of a whale's head attached to the pillar, the whalebone which takes the place of teeth hangs in great plates from the inside of the upper jaw. This whalebone acts as a strainer in the mouth of the whale and extracts the small animals from the sea water which the whale takes into his mouth when feeding. The food consists mostly of tiny crustaceans less than an inch in length. Although whales and porpoises live in the water they are not fishes, but are warm-blooded and breathe by means of lungs, not gills. The whale must come to the surface to breathe and the so-called "spouting" is merely the result of the warm air being expelled from the lungs when he breathes. A whale does not spout *water* as is commonly supposed. Models to scale of the other whalebone whales, and the toothed sperm whale, and skeletons of the smaller whales are hung near for comparison.

Mammals of the World

Model of Sulphur-bottom Whale

The case along the gallery rail contains insects of many kinds which are placed here temporarily — butterflies, moths, beetles, spiders, locusts, katydids, etc., in infinite variety. Protective coloration and mimicry are well exemplified.

SOUTHEAST PAVILION

Hall of Insect Life

Proceeding east, we enter the *Insect Hall*. The installations in this hall point out the relationships, through origin and mode of life, of insects to

each other and to the other members of the Animal Kingdom, especially to man. The exhibits are arranged in a continuous series, and are numbered so that we can easily follow the plan beginning at the pillar farthest to the left.

Insect Life

Importance of Insects

First is an introductory section illustrating by diagrams the importance of insects as shown (a) by the large number of species compared with other animals [there are more species of insects than of all other animals put together] and (b) by their great influence on human interests. In the United States, the economic loss by insects is more than five times as great as by fire and there are more than twelve times as many deaths from insect-borne diseases as from railroad accidents. On the other hand, many of our crops and all beautiful flowers are largely dependent upon pollination by insects.

Evolution as Illustrated by Insects

Next in order is given an outline of the development of insects as a race, their geological history, anatomy, physiology and embryology. Then begins a graphic discussion of the principles underlying evolution as illustrated by insects.

Insect Habits

Turning to the table cases at the northeast corner of the room, we find photographs of prominent American entomologists; also short biographies and bibliographies which form an introduction to the more detailed study of insects. One case is devoted to collecting apparatus and one to the classification of insects and their allies with typical specimens to illustrate each group. Another case treats of insect architecture. Others show how insects pass the winter, how they lay their eggs, catch their prey, etc. Collections of insects from particular environments and at special seasons hint at the interesting studies to be made along these lines.

Insects and Man

Then come a series of exhibits concerned with the enemies of insects ending with man and showing how insect pests are combated. Another side of the question is then taken up; the carrying of disease by insects. Household insects, aquatic insects and insects which live underground in plants and on their leaves (including some fine models of plant galls produced by insects) are also shown. Beneficial insects such as the silk worm and honey bee are treated in some detail, and in connection with the latter are taken up social insects in general.

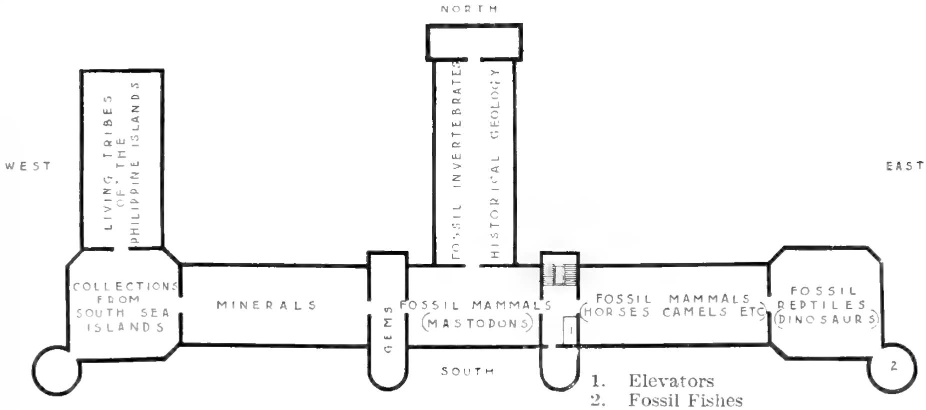
Local Collection

Visitors desirous of studying specimens of local insects more in detail are cordially invited to do so by consulting the nearly complete collection to be found in this hall under the custody of the New York Entomological Society.

[*Return to the elevators and ascend to the Fourth Floor.*]

THE MAORI WARRIOR

Cast from a living Maori in the pose of a defiant warrior. The boulder of jade on which the figure stands is the largest that has ever been brought from New Zealand



FOURTH FLOOR

Foreword on Fossil Vertebrates

In the *East Corridor,* and the *South Pavilion* at the left, as well as in the *East Wing* and *Southeast Pavilion* at the right are displayed the fossil mammals, reptiles and fishes.

In a general way, fossils are the petrified remains of plants or animals that lived at some past period of the earth's history. In many instances we have not the objects themselves but only their casts or impressions in the rocks. This is particularly the case with shells. Sometimes, as with the bones of the great Irish elk the objects have been buried in swamps or bogs, and in a few rare instances as with the mammoth and woolly rhinoceros, entire animals have been preserved for thousands of years in ice or frozen mud. Fossils are found in localities where the dead animals or plants have gradually been buried under layers of sediment to such a depth that they come in contact with the mineral waters of the earth and finally become petrified. Later through subsequent upheaval and erosion they are again brought to or near the surface of the earth. Petrifaction is the slow replacement of animal or vegetable material by such minerals as carbonate of lime or silicate. The process is very slow and for this reason flesh is never petrified. Fossil beds are found in every continent. In our own country, Texas, Montana, Wyoming, and the Bad Lands of South Dakota are famous for their large fossil beds, and many of the finest and rarest fossils in the Museum were obtained in these localities.

As it takes thousands of years for the various layers of earth to accumulate over the bones, and for the latter to become petrified, the study of fossils and the strata in which they are found is an important aid in determining the age of the earth and the succession of life thereon. Nearly

all of the skeletons exhibited in these halls are of animals which lived from 30,000 to 20,000,000 years ago. To prepare a specimen for exhibition the matrix in which the bones are imbedded is carefully chipped away and the missing parts restored in cement and plaster. The bones are then assembled as in life. In the specimens on exhibition the restored parts differ in color from the original parts of the skeleton and can readily be distinguished.

As a whole, the Museum collections of fossil vertebrates are believed to be the finest in the world, if we take into consideration not merely numbers, but also variety, quality and perfected methods of preparation and exhibition. The collections illustrating the evolution of the horse are probably equal to those of all other institutions combined. The collections of Permian reptiles, of Jurassic and Cretaceous dinosaurs, of turtles, of North American Tertiary mammals, and of extinct mammals of South America, are likewise of the first rank. There are more than seventy complete skeletons on exhibition, several hundred skulls and nearly two thousand jaws or other parts of various species. About ten times this number are in storage, reserved for study and research, or not yet prepared for exhibition.

WEST CORRIDOR

Fossil Fishlike Lizards

Directly in front of the elevator is a wall case in which the most recently acquired specimens are placed. The cases attached to the wall near the stairway contain specimens of huge marine fishlike lizards, which show the tremendous pressure to which fossils are often subjected and the fragmentary condition in which they are found.

SOUTH PAVILION

Mastodons and Mammoths

The visitor should first enter the *South Pavilion* in which are shown the skeletons of mammoths and mastodons, the prehistoric relatives of the modern elephants, and of the curious and extraordinary extinct animals which inhabited South America in prehistoric times, 30,000 to 100,000 years ago. On the left is a series of modern skeletons illustrating the evolution of the horse under the hand of man. Here are such extremes as the Shetland pony,

THE GROUP OF GIANT GROUND SLOTHS

Fossil mammals from South America adapted for digging about the roots of trees for the purpose of pulling them down to feed on the leaves and twigs

only two feet ten inches high, and the rough-boned draught horse, which stands six feet one inch in height. Contrast these with the slender-limbed "Sysonby" the famous race horse, and the Arabian stallion "Nimr." Man by his intelligence has modified the form of the horse to meet his needs and has accomplished in a small degree but rapidly, what nature has done in an extensive way during long ages — as will be seen from the fossil horses in the next hall. The similarity in structure of the skeletons of horse and man is brought out in the exhibit of a rearing horse being controlled by man. A comparison of these two skeletons will show that with some modification the bones of the one correspond with the bones of the other. The horse lover will also be interested in the osteological collections in the wall cases which show how to tell the age of horses through the growth and development of the teeth.

Skeletons of Modern Horses

Beyond the horse exhibit on the left are fossils from South America, the most striking of which is the group of giant ground sloths. There are also good examples of the Glyptodon, a sort of gigantic armadillo with its peculiar shell-like covering, the saber-toothed tiger and other singular extinct animals peculiar to South America. Although these animals were contemporaneous with the North American mammals of this period, they are so different in structure from any other known mammals, that it is practically certain that during their evolution South America was an island continent without land connection with North America.

Fossil Mammals of South America

The principal exhibits on the north side of the hall are the mammoths and mastodons and the series of skulls showing the evolution of the elephants. The "Warren Mastodon" is a classic specimen. It was found near Newburg, N. Y. in 1846, and is the finest specimen of its kind that has ever been discovered. While to the lay mind mastodon and mammoth are one, note that there are as great differences between them as there are between a deer and a moose. The mammoth and the mastodon were almost world-wide in their distribution, their remains being found on every northern continent, those of the mastodon in South America also. The modern elephants are confined to a limited area in India and Africa. While modern elephants are not direct descendants of the American elephants, they have originated from species in Asia which were contemporaneous with the mammoth and mastodon. Without any doubt prehistoric man hunted these animals.

Warren Mastodon

SOUTHEAST WING

Fossil Mammals of the Tertiary Period

Return to the East Corridor and continue into the *Southeast Wing* or Tertiary Hall which contains the Fossil Mammals of the Tertiary Period.

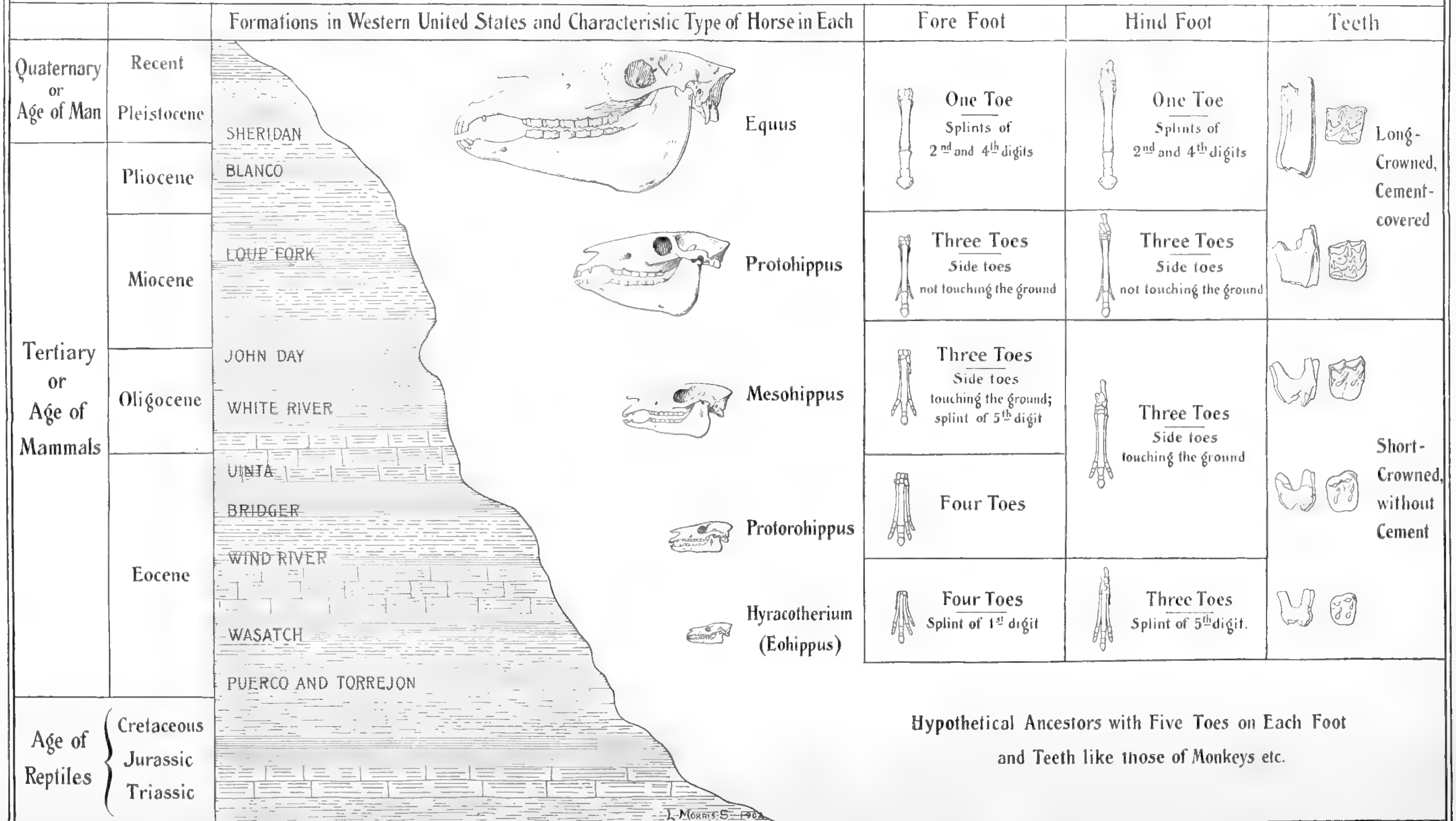
The geological age to which all the fossils shown in this hall belong, covers a period of from 100,000 to 3,000,000 years. At each side of the entrance are charts indicating the successive periods of time from the Triassic to the Tertiary, and the animal life which pertained to each. Careful guides and exhaustive cards of explanation, photographs, and window transparencies combine to make the entire exhibit illuminative and interesting.

Restoration of *Eohippus*, the four-toed horse. This ancestor of the modern horse, scarcely larger than the red fox, lived some three millions of years ago. It comes from the Lower Eocene of Wyoming and New Mexico

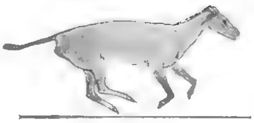
The particular gem of this hall is the wonderful series in the cases by the entrance and in the first alcoves on the right showing the evolution of the horse in nature. The Museum is justly proud of this collection. Not only is it the largest and finest series of fossil horse skeletons in the world, but it is larger than the combined collections of all other institutions, and it contains the earliest known ancestors of the horse, the little four-toed *Eohippus*,

Evolution of the Horse

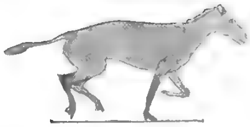
THE EVOLUTION OF THE HORSE.



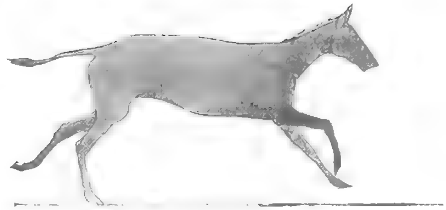
The history of the evolution of the horse through the Age of Mammals gives the best example in existence of the doctrine of evolution by means of natural selection and the adaptation of a race of animals to its environment. During three millions of years, these animals passed through important changes especially in the teeth and feet, adapting them more and more perfectly to their particular environment, namely open plains with scanty stunted herbage



Eohippus



Orohippus



Mesohippus

which was no bigger than a fox and on four toes scampered over Tertiary rocks. As will be seen by an examination of the skeletons of the horse and man in the Quaternary Hall, the modern horse walks on the tip of his middle finger and toe. The front hoof bone corresponds to the last joint of the third finger in the human hand, and the other bones of the leg correspond bone for bone with the structure of the finger, wrist and arm of man. In the modern horse the remaining fingers or toes of the fore and hind foot have entirely disappeared, or remain only as vestiges, the so-called "splint bones." The structure of the modern horse shows that it developed from a five-toed ancestor. This ancestry has been traced back to the four-toed stage.

In the wall case at the right of the entrance is given a synopsis of the evolution of the foot and skull of the horse and the geological age in which each stage is found. Across the alcove the visitor will find the skeleton of *Eohippus*, the four-toed stage of the horse and the earliest form that has been discovered. This specimen is from the Wind River beds of Wyoming and may have lived 3,000,000 years ago. It is interesting to note that while there were no horses found in this country by the white settlers, America is the original home of the horse.

Passing from skeleton to skeleton the changes that have taken place in the development of the horse are easily distinguished. The exhibit is made more lifelike by plaster restorations of the animals and by water-color sketches showing primitive horses in their environment. These paintings and models are by Charles R. Knight. In the later types of the three-toed stage the two lateral toes have lost their original function of support and are gradually become vestiges. The three-toed horse in the center of the alcove is one of the most complete and finest examples that has ever been unearthed.

Opposite the horse exhibit on the other side of the hall, are series of specimens illustrating the evolution of the camel, deer and the other cloven-hoofed animals. These animals like the cow of to-day walked on the tips of the third and fourth fingers, and the gradual disappearance or reduction to useless vestiges of the other fingers and toes can be traced as in the horse series.

Giraffe Camel and Giraffe

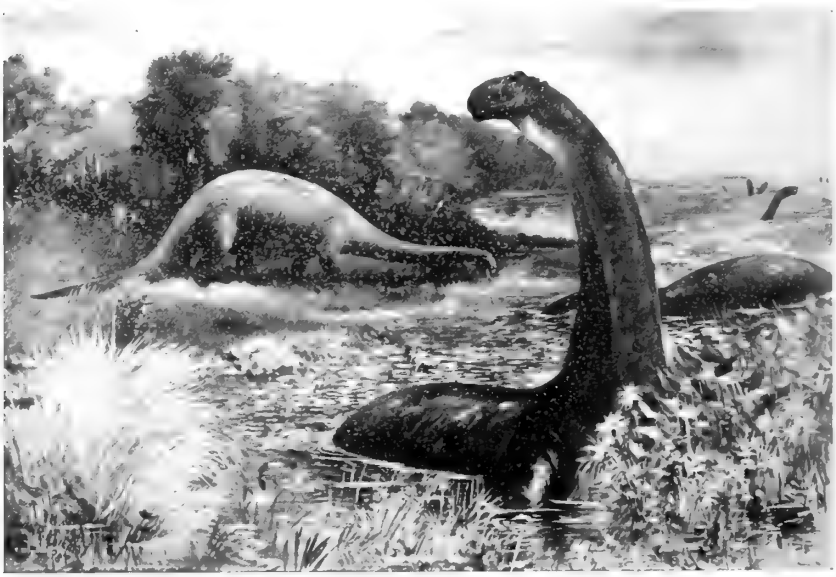
Giant Pigs and Pygmy Hippopotamus

A curious and remarkable instance of parallel evolution is furnished by the cases of the giraffe camel and the giraffe. The former was descended from the primitive camel which lived in North America, while the giraffe had for its ancestor the primitive antelope of the Old World; thus each species evolved independently of the other. The giant pigs, or elotheres and the pygmy hippopotamus will repay examination.

Rhinoceros

The primitive rhinoceros-like animals are shown near the center of the hall on the right. It seems hard to believe that our vast western country and indeed all North America, was once the home of the rhinoceros. As here indicated vast herds roamed over the fields in the Tertiary Period and their fossil remains are found imbedded in the Plains of South Dakota. Opposite these are shown the ancestors of the dogs, cats and other carnivores, among which is the giant saber-toothed tiger.

On the south side on the right are skeletons of titanotheres, on the left of uintatheres, huge extinct, horned animals peculiar to North America.



Restoration of *Brontosaurus*. One of the largest of the amphibious dinosaurs, cold-blooded, slow-moving, unintelligent creatures that grew to large size (65 ft. in length) in the rich vegetation of the Reptilian era

Rough drawing to show scale of size of *Tyrannosaurus rex.* This carnivorous dinosaur was the largest beast of prey that ever lived. The Museum possesses one Tyrannosaurus skeleton from South Dakota and two from Montana

SOUTHEAST PAVILION

Fossil Reptiles and Fishes

The visitor now enters the *Southeast Pavilion* containing the dinosaurs and other fossil reptiles and also fishes. These animals belong to a more ancient period than the specimens just examined. They lived from 3,000,000 to 10,000,000 years ago. They include the well-known dinosaurs of which the Museum has a large collection. In the wall case on the left is a portion of the skeleton of the dinosaur *Diplodocus*; this was the first of these specimens to be unearthed by the Museum.

The Dinosaur Diplodocus

The gigantic skeleton in the center of the hall is the huge extinct reptile, the dinosaur *Brontosaurus,* found in the Jurassic beds of Wyoming. It is the only mounted specimen of its kind in the world and more than two-thirds of the skeleton is the original petrified bone. It is sixty-six feet eight inches in length, sixteen feet in height and is estimated to have weighed when alive thirty-five tons. Brontosaurus is one of the largest giant reptiles and as is indicated by its teeth was herbivorous, probably living on the rank water weeds of the nearly sea-level marshes of Wyoming. Contrasted with the herbivorous Brontosaurus, is the carnivorous dinosaur *Allosaurus,* mounted to represent the animal feeding on the fallen carcass of a Brontosaurus, upon which it preyed. This is not a fanciful mounting for these very skeletons were found in close proximity to each other in the Jurassic beds of Wyoming, and the skeleton of the fallen Brontosaurus shows gouges made by the teeth of Allosaurus as it tore the flesh from its victim.

Brontosaurus

Allosaurus

Near the Allosaurus group is a portion of a skeleton of *Tyrannosaurus*

TRACHODONS OR DUCK-BILLED DINOSAURS

Fossil reptiles, fifteen to sixteen feet high and thirty feet long, with spreading webbed feet, compressed tail and duck-like bill, all of which indicate a more or less aquatic existence

the last and most powerful of the carnivorous dinosaurs. Like Allosaurus it has enormous three-toed hind legs armed with sharp claws, and smaller fore legs. Tyrannosaurus is from Montana and the matrix in which it was found is as hard as flint.

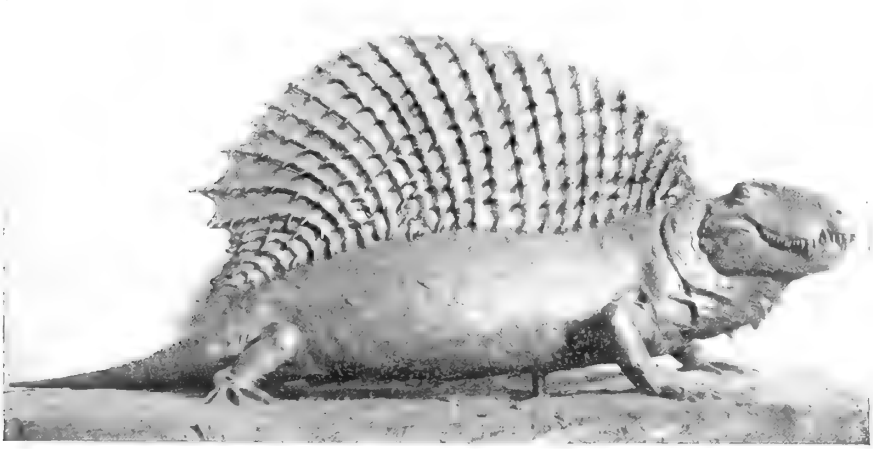
Tyranno-saurus

To the left of Brontosaurus are two complete specimens of the duck-billed dinosaur *Trachodon*. One shows the animal erect and standing on guard, while the other is shown feeding on shellfish and plants of the Cretaceous swamps of Montana.

Trachodon

In the low case in front of this group is one of the most interesting reptile specimens which has ever been discovered. It is a mummified duck-billed dinosaur, Trachodon, the skin of which is wonderfully well preserved, and for the first time the character of the outer covering of this animal is fully revealed. The animal is lying on its back and, in spite of its crushed condition, its form is easily distinguishable. It probably died on a sand bank or near a shoal where the hot winds dried up the flesh until the skin adhered to the bones like a close-fitting glove, and was subsequently buried by a flood.

Other specimens shown in the hall include the smaller carnivorous dinosaurs, the horned dinosaurs with, in one instance at least, a skull seven feet in length, and giant birds possessed of teeth. There is also the finback lizard, one of the most ancient of fossil reptiles; *Diadectes*, a reptile with a solid-boned skull and *Eryops*, a primitive amphibian. The finest collection of fossil turtles in the world will be found on the south side of the hall.



Model of *Naosaurus* or "Ship-Lizard," an ancient and grotesque reptile. Collected in Texas; length eight feet

In the *Tower* of the Southeast Pavilion are displayed the fossil fishes which belong to a much earlier period than the mammals and reptiles, some of them having lived twenty to fifty millions of years ago. Many of these forerunners of backboned animals are quite unlike any living fishes and are probably only very indirectly related to them; some were small, curiously encased in shells; others, shown in the three cases in front of the visitor, attained large size and were evidently formidable creatures. One of them in fact, *Dinichthys*, shown in the middle of the gallery, was probably among the most destructive creatures that ever lived in the sea. Its jaws were so strong that it could crush a plate of bone as thick as one's hand. Such an actual specimen, fractured in life and showing the marks of "teeth" is shown in a neighboring case.

Fossil Fishes

The collection is so arranged that he who makes the tour can see the principal kinds of fossil fishes and is able, in a measure, to outline the history and pedigree of the entire group. He can trace the rise and fall of the early plate-covered fishes; the era of the sharks which on the one hand supplanted the earliest fishes and were in time replaced by the more efficient lungfishes and ganoids; the age of ganoids when the waters were filled with these enamel-scaled fishes; finally the age of the bony-fishes, or teleosts, the multitudinous forms of to-day, the herrings, cods, perches, whose methods of swimming, feeding and breeding are far more efficient than those of any of their predecessors.

Above the entrance are the jaws (models), spreading nine feet, of a huge fossil shark in which the actual teeth are arranged as in the sharks of to-day, in the usual banks or rows — the teeth in the hinder rows having served to replace those in front. Such a shark probably measured from seventy to ninety feet and its race may well have become extinct, when for various reasons the enormous volume of food necessary to support it could not be maintained within its range of sea.

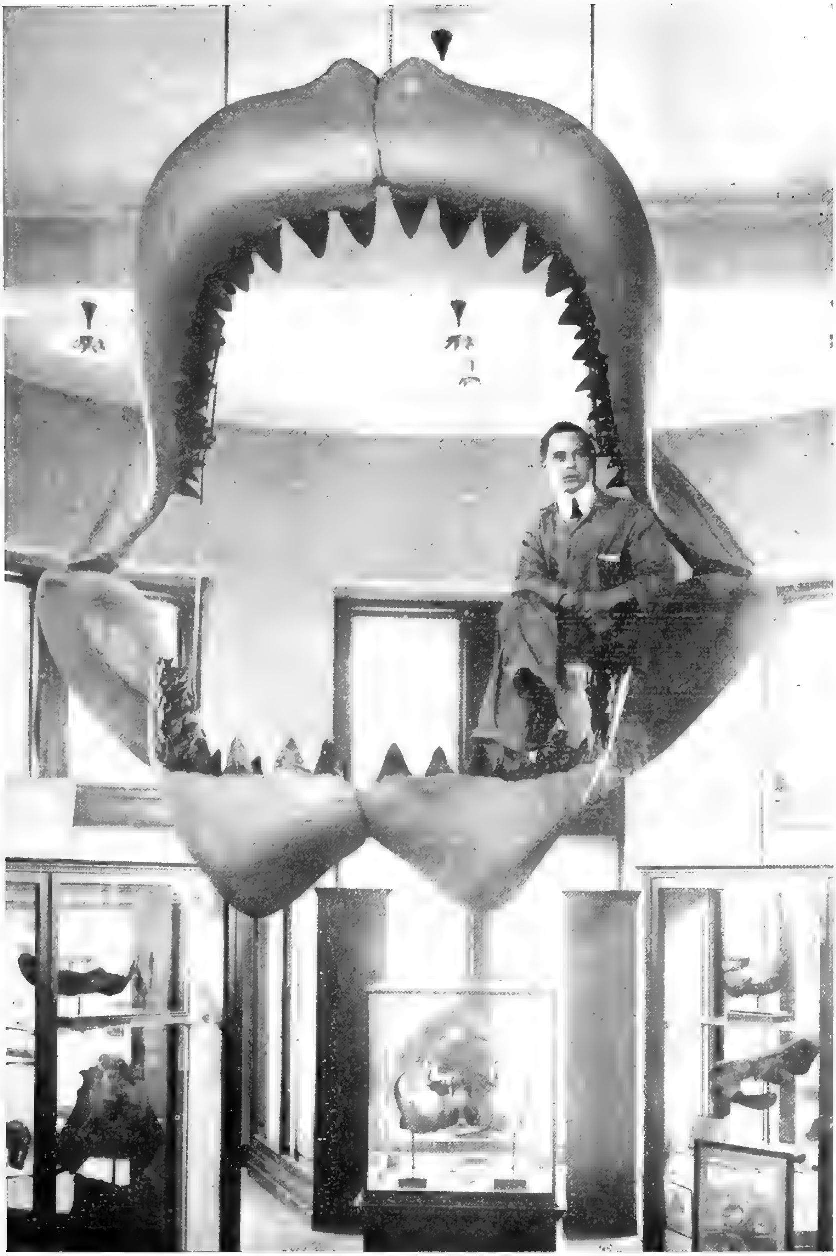
Jaws of Huge Fossil Shark

Fossil Aquarium

In the first alcove to the left, by the window, is a "fossil aquarium" in which a number of models of these earliest fishes are arranged in a group, as though alive in the sea.

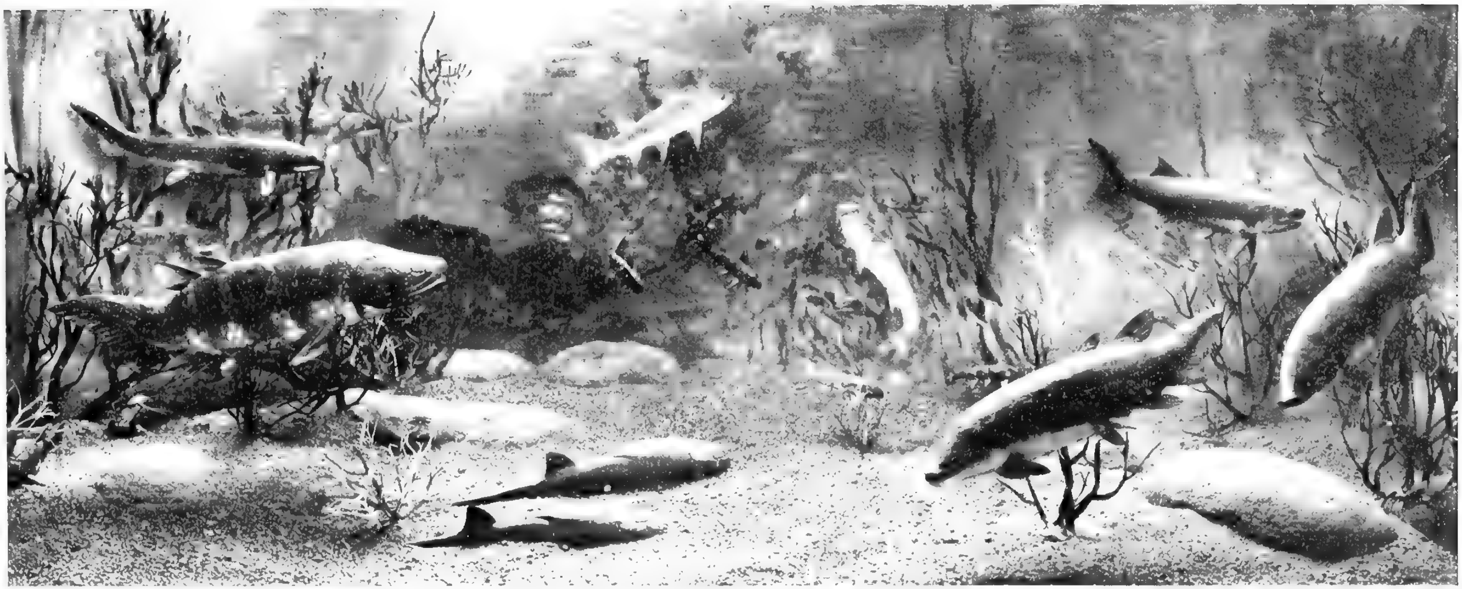
In the next alcove are the early fossil sharks which superseded the tribe of plated fishes just mentioned. These sharks had soft skeletons, simple fins and a number of other primitive features which lead to the belief that all of the higher fishes, and the higher backboned animals therefore as well, were descended from them, their simpler structures becoming more complicated in many directions. In one of the early sharks here exhibited, soft parts such as muscles and gill filaments, have been petrified.

Sharks



RESTORATION OF THE JAWS OF A FOSSIL SHARK

This largest and most formidable fish, living or extinct, of which we have any record frequented the coast of South Carolina in Tertiary time. The jaws measure nine feet across; estimated length of fish, eighty feet



THE "FOSSIL AQUARIUM" IN THE FISH GALLERY

This shows what can be done to make these ancient forms appear as living. The group illustrates the typical "Age of Fishes," Devonian, in which the forms came from a single locality (Cromarty) and a single rock layer in the Old Red Sandstone of Scotland

In the third alcove appear rare fossils of silver sharks or Chimæroids,

Chimæroids

which appear to have been developed from a primitive race of sharks. Curiously enough fossil egg capsules of these forms are sometimes preserved, and examples are here present. In neighboring cases are shown ancient lungfishes and ganoids — groups from which all land-living quadrupeds are believed to be descended.

In the fourth alcove are shown the ganoid fishes which dominated the

Ganoids

waters during the Age of Reptiles. They were of many kinds and sizes, most of them with lozenge-shaped scales of bone, with enamelled surface. One of the few survivors (*Amia*) of this ancient group is here shown living (in a window aquarium), to give the visitor a clearer idea of the fishes of the "Middle Ages" of the world.

In the fifth alcove are the petrified fishes of the Age of Mammals. By

Teleosts

this time nearly all of the primitive fishes like sharks, lungfishes and ganoids, had become extinct; and the common forms were bony-fishes, or teleosts, closely related to our herrings, perches, mackerels and daces.

[*Return to the South Pavilion or Hall of Mastodons and Mammoths.*]

SOUTH CENTRAL WING

Geology and Invertebrate Palæontology

Turning northward at the center of the Quaternary Hall containing the mastodons and mammoths, the visitor enters the *South Central Wing* of the building and is in the Hall of Geology and Invertebrate Palæontology. At the entrance of the hall there is a large slab of fossiliferous limestone from Kelleys Island in Lake Erie near Sandusky, whose surface has been

Glacial Grooves

smoothed, grooved and scratched by the stones and sand in the bottom of the vast moving ice sheet or glacier that covered the northeastern part of North America during the Glacial Epoch. The front of this continental glacier is now thought by most geologists to have retreated northward across Lake Erie from 30,000 to 50,000 years ago. At Kelleys Island, the ice was moving from east to west. Just beyond the glacial groove specimen, the visitor will see an exhibit illustrating some of the results of an expedition which the Museum sent to Martinique and St. Vincent during the great volcanic eruptions of 1902–

Volcanic Bombs

1903 that devastated those islands of the Lesser Antilles chain. A set of four relief maps shows the island of Martinique and its famous volcano, Mont Pelée, at three important stages of the

eruptions, while the nearby cases and pedestals contain relics of the ruined city of St. Pierre and the dust, stones and bread crust bombs that were thrown out in a white hot or molten condition by this volcano and by the Soufrière of St. Vincent. Some 30,000 people were killed by these outbreaks. Important geological facts were learned from the observation and subsequent study of the series of events.

At the north end of the hall, there is the reproduction of part of a marvelously beautiful cave that was discovered early in 1910 in the mining operations at the famous Copper Queen mine at Bisbee in the southeastern part of Arizona. The cave was formed by the dissolving action of water traversing joints in limestone, and its walls, roof and bottom were afterward coated with calcite (calc spar) incrustations, stalactites and stalagmites, some of which are dazzling white while others are colored green with copper salts or pink with iron compounds.

Fossilized Tree Stump

In the alcove across the hall from the cave, the visitor may see the stump and part of the roots of a large tree from an anthracite coal mine under Scranton, Pa. Millions of years ago, in the geological period known as the Carboniferous, this tree grew upon the top of a thick swamp deposit of decaying vegetation which ultimately became a most valuable bed of coal. The stump was left in the roof of the mine when the coal was extracted for commercial and domestic uses. It fell to the floor years after the gallery had been abandoned and was discovered only through the chance visit of a miner.

The cases along both sides and down the middle of the hall contain geological and palæontological specimens. Palæontology is the science of the ancient life of the earth; its field is the study of the fossilized shells and other hard parts and the various kinds of imprints left by the animals formerly inhabiting the seas and lands, and preserved in deposits which now form our stratified rocks. As normally the upper layers of a series of strata are more recent than the lower, the fossils reveal the succession of life forms in the earth's crust and thus are of the highest value and interest to the student of historical geology. Since, however, the remains of only a small proportion of the animals living at a given period are permanently preserved in the marine, river, lake and subaërial deposits of that period, the geological record of animal and plant forms is far from complete. Inasmuch as invertebrate animals are far less free in their movements than the vertebrate forms, they are accepted as the best determinants of the geological age of a bed of rock, even when remains of both kinds are found together. Invertebrate life too appeared on the globe far earlier than vertebrate, and remains of certain species are abundant in the lowest (oldest) of our stratified rocks.

The specimens in the cases are arranged to illustrate historical geology,

beginning at the northeast corner of the hall with the archæan rocks, which are the lowest and oldest of all and contain no fossils, advancing regularly southward along the east side through the Cambrian, Ordovician, Silurian and Devonian systems, passing to the west side of the hall in the Devonian and continuing through the Carboniferous, Jurassic, Triassic, Cretaceous and Tertiary. Thus far the specimens are from American localities, but the northwest quarter of the hall is devoted to a synoptic series of European fossils. The cases in the middle of the hall contain overflow material from the sides. The American series is subdivided into geographical provinces, the fossils from New York State and other eastern regions being placed first and then the material from the Central West and beyond. Under the geographical subdivision the species are arranged according to their position in the scale of life — that is, following a biological classification, the lower or simpler forms being placed first. The diamond-shaped bits of emerald green paper attached to some of the specimens indicate those, more than 8,000 in number, known as "types" or "figured specimens," which have been used by James Hall, R. P. Whitfield and others in the original description and naming of species or in their elucidation.

Series to Show Historical Geology

The upper shelves of the wall cases contain particularly large or striking specimens of fossils, or blocks of rock illustrating the geological features of the horizons in which the fossils occur.

Geology of Manhattan Island

Two floor cases in the middle of the hall at the north end contain a series of rock specimens showing the geology of Manhattan Island and a very complete collection of the minerals found in New York City and immediate vicinity belonging to the New York Mineralogical Club.

Attention may be called also to the collection of Michigan copper ores, orbicular granites and diorites from several parts of the world, fossil crinoids from Waldron and Crawfordsville, Indiana, fossil corals from the Devonian reefs near Louisville, Kentucky, fossil crinoids and an immense clamlike shell from the Cretaceous of Nebraska, fossil plants from Tertiary beds at Florissant, Colorado. The windows contain some colored transparencies from photographs of interesting scenery in the West.

[*Return to the Hall of Mastodons and Mammoths and turning to the right enter the West Corridor or Gem Hall.*]

A PORTION OF THE GEM HALL

In the wall cases are many fine examples of quartz, calcite, malachite, azurite, and amethyst. In the desk cases are cut and uncut diamonds, sapphires, topaz and other gems. The collection, presented to the Museum by Mr. J. P. Morgan, includes many large and rare forms which could not be duplicated

WEST CORRIDOR

Gems and Precious Stones

The *West Corridor* contains the Morgan gem collection. This splendid series of gems and precious stones was presented to the Museum by Mr. J. P. Morgan, one of the founders and a Trustee of the institution. It includes many large or rare forms, some of which could not be duplicated. In the wall cases are fine samples of quartz, calcite, gypsum, and Iceland spar which makes a double refraction of light rays thereby causing objects seen through it to appear double; malachite of such soft texture that it appears more like velvet than stone; tourmaline of varied hue; azurite of indescribable tones of blue, and enormous slabs of amethyst crystals, the last named among the largest and finest specimens ever taken from a mine. The smaller and more valuable gems are shown in the desk cases, the raw material or uncut gem being placed in the center of each case and the cut stones around it. The diamonds, sapphires, the topaz, amber and native gold are exhibits of unusual interest. Case labels describing the formation, properties and localities of each gem are attached to the case. [The collection of gems is more fully described in *Guide Leaflet* No. 4.]

Gems and Precious Stones

SOUTHWEST WING

Minerals

Next beyond the Gem Hall is the *Southwest Wing* or Hall of Minerals. At the entrance to the hall is a case in which recent acquisitions are placed. The general collection of minerals consists chiefly of the well-known Bement Collection which contains specimens representing species of the known minerals of the world. Not only is the collection noted for its numbers, but in many instances the beauty and size of the individual specimens are quite unsurpassed in other collections.

Bement Collection

The more attractive specimens are displayed in cases arranged down the center of the room. The remainder of the collection is arranged according to the classification of minerals. In the first cases on the right or left the visitor is introduced by models to the various types of crystallization. Each mineral has a characteristic form of crystallization which is one of the means of identifying it. The distribution of the more important minerals is indicated on maps. [See *Guide Leaflet* No. 4.]

GENERAL VIEW OF THE PHILIPPINE HALL

SOUTHWEST PAVILION

Collections from the South Sea Islands

Entering the *Southwest Pavilion* beyond the Hall of Minerals the visitor will find specimens pertaining to the natives of the Pacific Islands. The wall cases contain examples of war implements, tapa or bark cloth, sacred masks, boomerangs and armor.

The cases in the center contain Kava bowls, head rests, shell and ebony armlets and other ornaments, betel spatulas, ceremonial paddles, hats, mats and baskets. These people follow the custom of tattooing themselves. Their occupations as here detailed are peaceful rather than warlike. The swinging picture-frames on the left of the entrance midway down the room give some idea of the dress, customs, and pastimes of the Samoan Islanders. Note the delicate workmanship expended on the feather capes worn as robes of honor by great chiefs of Sandwich Islands. The jade boulder from New Zealand supports a figure representing a Maori warrior in an attitude of defiance.

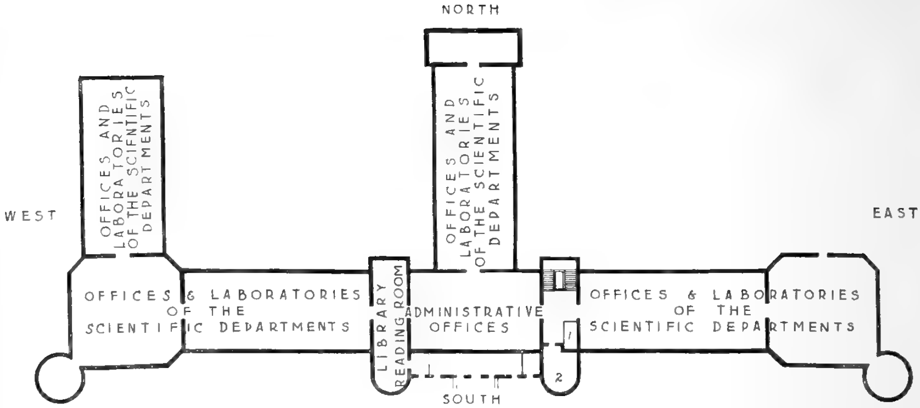
WEST WING

Collections from the Philippines

The hall due north beyond the Hall of the Pacific Islands is devoted to a collection from the Philippine Islands. The installation here as in the African hall is geographical. The specimens of wood along the walls are Philippine woods. The palm leaf mats above the windows around the hall are in some cases very beautiful. The brass-work, boar-bristle tooth brushes, necklaces, shell bracelets, knives, spears, bead-ornamented combs, medicines, guitars, horse accoutrements evidence superior workmanship. These people present a higher civilization than their South Sea Island neighbors. The exhibit of clothing distinctive of each tribe is very complete. The model at the entrance depicts a woman weaving a garment similar to some of those seen in the cases. The house in the tree at the end of the room is a life-size copy of a tree-house such as the Lake Lanao Moros build. Full information concerning the tribes is given in various descriptive labels.

Living Tribes of the Philippine Islands

[*Return to the elevators.*]



1. Elevators
2. Office of the Director

FIFTH FLOOR

The fifth floor is given over to the administrative offices, the offices and laboratories of the scientific departments and the library. The reading room of the library is located in the west corridor, and is open free daily from 9 A. M. to 5 P. M. except Sundays and legal holidays. The library is a reference library containing some 70,000 volumes devoted to the natural sciences, a collection that has been accumulated for a three-fold purpose—namely, to supplement the exhibits of the Museum with the literature pertaining to them, to supply the natural history student with the most important scientific works, and to furnish the general reader with the more popular books such as give accurate but less detailed information, and at the same time stimulate a more intense study of nature.

These aims in building up the collection of books have been fulfilled to such an extent that the Library now contains over 15,000 volumes on zoology, comprising many of the extremely rare and interesting monographs in ornithology; an excellent collection of 3500 volumes in entomology including many of the rare classics and a 2000 volume collection in conchology containing the standard works of Küster, Reeve and Binney. There is also a well selected collection of 2500 volumes in anthropology including many of the older works relating to the North American Indian; an excellent collection of 3500 volumes in geology enriched by the library of the late Professor Jules Marcou; a collection of 5000 volumes in palæontology to a large extent composed of the Osborn Library of Vertebrate Palæontology; also an unusually complete collection of more than 25,000 volumes of natural science periodicals. These with the Bickmore Library of travels and a small but carefully selected assortment of books relating to scientific voyages give the library of the Museum important educational value. A rack in the reading room contains current issues of many scientific periodicals.

INDEX

Page numbers of illustrations are set in heavy face type

No. 18.— THE MOUNTED SKELETON OF BRONTOSAURUS. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. April, 1905. *Out of print.*

No. 19.— THE REPTILES OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. July, 1905. *Out of print.*

No. 20.— THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY. By RAYMOND L. DITMARS, Curator of Reptiles, New York Zoölogical Park. October, 1905. *Price, 15 cents.*

No. 21.— THE DEVELOPMENT OF A MOLLUSK. By B. E. DAHLGREN, D. M. D. January, 1906. *Out of print.*

No. 22.— THE BIRDS OF THE VICINITY OF NEW YORK CITY. By FRANK M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. April–July, 1906. *Price, 15 cents.*

No. 23.— THE SPONGE ALCOVE. By ROY W. MINER, Assistant Curator of Invertebrate Zoölogy. October, 1906. *Out of print.*

No. 24.— PERUVIAN MUMMIES. By CHARLES W. MEAD, Department of Ethnology. March, 1907. *Price, 10 cents.*

No. 25.— PIONEERS OF AMERICAN SCIENCE. Memorials of the naturalists whose busts are in the Foyer of the Museum. April, 1907. *Out of print.*

No. 26.— THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By EDMUND OTIS HOVEY, Ph.D., Associate Curator of Geology. December, 1907. *Price, 10 cents.*

No. 27.— THE MALARIA MOSQUITO. By B. E. DAHLGREN, D. M. D. Assistant Curator of Invertebrate Zoölogy. April, 1908. *Out of print.*

No. 28.— THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By FRANK M. CHAPMAN, Curator of Ornithology. February, 1909. *Price, 15 cents.*

No. 29.— THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER, Department of Anthropology. September, 1909. *Price, 10 cents.*

No. 30.— THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO. November, 1909. *Price, 5 cents.*

No. 31.— BRIEF HISTORY OF ANTARCTIC EXPLORATION. March, 1910. *Price, 10 cents.*

No. 32.— TREES AND FORESTRY. By MARY CYNTHIA DICKERSON, B. S., Curator of Woods and Forestry. September, 1910. *Price, 15 cents.*

No. 33.— THE PROTECTION OF RIVER AND HARBOR WATERS FROM MUNICIPAL WASTES. BY CHARLES-EDWARD AMORY WINSLOW, Curator of Public Health. April, 1911. *Price, 10 cents.*

No. 34.— PLANT FORMS IN WAX. By E. C. B. FASSETT. November, 1911. *Price, 10 cents.*

No. 35.— GENERAL GUIDE TO THE MUSEUM. Prepared by GEORGE H. SHERWOOD, Curator of Public Instruction. November, 1911. *Price 15 cents.*

Guide Leaflets published by the

AMERICAN MUSEUM OF NATURAL HISTORY

For Sale at the Museum

No. 1.— THE BIRD ROCK GROUP. By F. M. CHAPMAN, Associate Curator of Mammalogy and Ornithology. October, 1901. *Price, 10 cents.*

No. 2.— THE SAGINAW VALLEY COLLECTION. By H. I. SMITH, Assistant Curator of Archæology. December, 1901. *Price, 10 cents.*

No. 3.— THE HALL OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Assistant Curator of Vertebrate Palæontology. January, 1902. *Out of print.*

No. 4.— THE COLLECTION OF MINERALS. By LOUIS P. GRATACAP, A. M., Curator of Mineralogy. February, 1902. *Revised edition*, May, 1904. *Price, 10 cents.*

No. 5.— NORTH AMERICAN RUMINANTS. By J. A. ALLEN, Ph.D. Curator of Mammalogy and Ornithology. March, 1902. *Revised edition*, February, 1904. *Price, 10 cents.*

No. 6.— THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By GEORGE H. PEPPER, Assistant in Anthropology. April, 1902. *Second edition*, May, 1909. *Price, 10 cents.*

No. 7.— THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. May, 1902. *Out of print.*

No. 8.— THE SEQUOIA. A Historical Review of Biological Science. By GEORGE H. SHERWOOD, A. M., Assistant Curator. November, 1902. *Price, 10 cents.*

No. 9.— THE EVOLUTION OF THE HORSE. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1903. *Second edition*, May, 1905. *Out of print.*

No. 10.— THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. February, 1903. *Price, 10 cents.*

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. MEAD, Assistant in Archæology. July, 1903. *Price, 10 cents.*

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. October, 1903. *Out of Print.*

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print.*

No. 14.— BIRDS' NESTS AND EGGS. By FRANK M. CHAPMAN. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted*, February, 1905. *Out of print.*

No. 15.— PRIMITIVE ART. July, 1904. *Price, 15 cents.*

No. 16.— THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY. By WILLIAM BEUTENMÜLLER, Curator of Entomology. October, 1904. *Out of print.*

No. 17.— THE FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY. By W. D. MATTHEW, Ph.D., Associate Curator of Vertebrate Palæontology. January, 1905. *Out of print.*

(Continued on page 3 of cover.)